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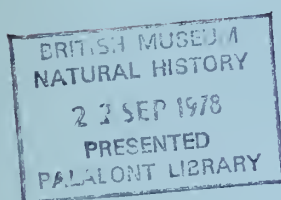
**Number 4**

**SUPPLEMENT TO THE LOWER TERTIARY FLORAS  
OF SOUTHERN ENGLAND**

**PART 5**

**BY**

**M. E. J. CHANDLER**



**PUBLISHED BY ORDER OF  
THE TERTIARY RESEARCH GROUP  
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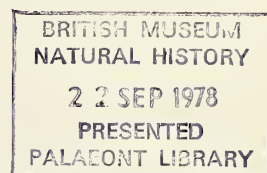
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**47 pages, 6 text-figures, 20 plates**

**September 1978**

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By  
Marjorie E.J. Chandler

PREFACE

This Monograph continues the *Lower Tertiary Floras of Southern England* series, published by the British Museum (Natural History), the first of which appeared in 1961.

The typescript was completed in 1968 and lay dormant until it was shown to Mr. R.L.E. FORD, who made it financially possible for it to be published.

In the years intervening between 1968 and 1977, the text-figures became separated from the rest of the typescript and have not been found. They have been redrawn by Dr. M.E. COLLINSON from re-investigation of the specimens and study of the manuscript descriptions. Miss CHANDLER herself has seen these figures and has gratefully agreed to their use in this publication.

As before, the photographs for the plates are by Miss CHANDLER, with the exceptions of Pl. 1, by Mr. J.N. CARRECK, and Pl. 20 by Mr. R. FLETCHER.

The prefix "V" to registration numbers indicates that the specimens are housed in the British Museum (Natural History), London.

August 1978

Margaret E. Collinson  
John Cooper  
Jeremy J. Hooker  
David J. Ward





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# SUPPLEMENT TO THE LOWER TERTIARY FLORAS OF SOUTHERN ENGLAND

## PART 5

By M. E. J. CHANDLER

### SYNOPSIS

A number of genera and species new to the London Clay are described. Additional material displays the characters of some hitherto inadequately known species and confirms the diagnostic features of species based originally on one specimen only. There are new locality records especially for Bognor, in some instances from tiny seeds or fruits difficult to determine.

Problems arising from preservation are discussed with especial reference to *Polycarpella* now placed in the Cyperaceae. The difficulties which arise from different types of preservation found in different deposits are considered and illustrated from actual instances. There are further comments on *Nipa* and corrections for several palm leaf localities.

An important new plant locality for the little known Hamstead flora has yielded large cones and foliage with remains of cuticle referable to *Sequoiadendron*. Foliage and cuticle equate this with *Araucarites* from Bournemouth of which the true generic relationship has always been questioned. Nine other Hamstead species are described.

A few additional plant fossils from Fehmarn Island, Schleswig-Holstein are recorded.

### INTRODUCTION

This supplement to the Lower Tertiary Flora is the outcome of work on new material from the London Clay and the Hamstead Beds. One or two specimens from other beds are also included so that published records may be as complete as possible. In the Systematic section full descriptions are given of new species or of those where new information has necessitated considerable alteration in earlier accounts or has led to changed ideas as to relationship. Where the existing Systematic descriptions are adequate and correct the discovery of certain additional details scarcely calls for repetition of the full formal description. Yet as every detail can be useful in establishing or confirming relationship to living plants these are incorporated with other relevant matter on pp. 11-14.

There is in addition further discussion on problems arising out of preservation. The determining and naming of fossil material, especially when it is of limited amount, perhaps one or two specimens only of a species, also receives some attention. There is especial reference to difficulties encountered in the naming of species illustrated by the Magnoliaceae and an explanation of how these can sometimes be overcome is demonstrated for the Vitaceae.

### PLANTS INCLUDED IN THE SYSTEMATIC SECTION

#### 1. FROM THE LONDON CLAY AND THE OLDHAVEN BEDS

Cyperaceae	<i>Polycarpella caespitosa</i> Reid & Chandler	formerly <i>Incertae Sedis</i>
Palmae	<i>Corypha wilkinsoni</i> n.sp.	Genus new to London Clay
	? <i>Trachycarpus</i> sp.	Genus new to London Clay
	<i>Palmospermum jenkinsi</i> Reid & Chandler	Sheppey; new locality
Araceae	<i>Epipremnum</i> sp.	Genus new to London Clay
Juglandaceae	<i>Pterocaryopsis elliptica</i> n.sp.	Genus previously based on one fruit only
Menispermaceae	<i>Daviscarpum gibbosum</i> Chandler	Previously based on one endocarp only
	<i>Atriaecarpum venablesi</i> (Chandler)	Formerly <i>Menispermicarpum</i> , fresh evidence as to seed
	<i>Atriaecarpum deltiiforme</i> n.gen & sp.	

Anonaceae	<i>Uvaria ovale</i> (Reid & Chandler)	Species based on seeds only, fruit now found
Capparidaceae	Genus?	Family new to London Clay
?Burseraceae	Genus?	
Sapindaceae	<i>Sapindospermum taylori</i> n.sp.	
Vitaceae	<i>Vitis</i> sp. (? <i>Vitis arnensis</i> Chandler)	Previous record of species in Lower Bagshot
	<i>Vitis bilobata</i> Chandler	Previously based on one seed
	<i>Vitis magnisperma</i> Chandler	Previously based on one seed
	<i>Vitis</i> sp. (? <i>Vitis excavata</i> Chandler)	One seed previously from Lower Bagshot
	<i>Vitis rectisulcata</i> Chandler	Additional seed from Oldhaven Beds of Upnor, Kent
	<i>Vitis</i> sp.	Distinctive but much pyrites encrusted
	<i>Ampelopsis crenulata</i> Reid & Chandler	Based originally on one seed, new material from Bognor & Sheppey
	<i>Tetrastigma sheppeyensis</i> Chandler	Two seeds, Bognor. Previous records Sheppey & Nursling
Rhizophoraceae	<i>Ceriops cantiensis</i> n.sp.	Genus new to London Clay
Compositae?	Genus?	Well preserved seed, Bognor. Family determination almost certain
Family?	<i>Carpolithus anthozoiformis</i> Chandler	Well preserved fruit
	<i>Carpolithus bellispermus</i> n.sp.	Highly distinctive seeds Bognor
	<i>Carpolithus</i> 3 species Bognor	
	Tuber or swollen Root Bognor	
	Tap Roots Sheppey, new	
	Branched Spines Bognor, new	
	Unidentified Dicotyledonous Twig	Sheppey, for comparison with <i>Equisetum</i>

## 2. FROM THE BARTON BEDS

Anonaceae	<i>Anonaspermum</i> sp.
-----------	-------------------------

## 3. FROM THE HAMSTEAD BEDS

Taxodineae	<i>Sequoiadendron fordii</i> n.sp. <i>Sequoia couttsiae</i> Heer	Similarly preserved for comparison with the above
Abietineae	<i>Pinus fordii</i> n.sp.	Cone
Palmae	<i>Pinus</i> sp. <i>Sabal major</i> (Unger)	Ironstone cast of leaf
	Genus?	Fruit
	Genus?	Ironstone cast of pinnate leaf
Hydrocharitaceae	<i>Stratiotes acuticostatus</i> Chandler	Seeds <i>in situ</i>
Droseraceae	<i>Aldrovanda intermedia</i> Reid & Chandler	Seeds <i>in situ</i>
Family?	?Unidentified Flower	

## 4. FROM FEHMARN ISLAND, SCHLESWIG-HOLSTEIN

Euphorbiaceae?	<i>Wetherellia variabilis</i> Bowerbank	Five large fruits
Anacardiaceae ?	<i>Lobaticarpum variabile</i> Reid & Chandler	New record
Epacridaceae	<i>Leucopogon quadrilocularis</i> Reid & Chandler	New record
Taxodineae	? <i>Sequoia couttsiae</i> Heer	New record



**PLANTS NOT DESCRIBED IN FULL DETAIL IN SYSTEMATIC SECTION BUT DISCUSSED  
AND IN SOME CASES ILLUSTRATED FOR SPECIFIC REASONS**

Nipaceae	<i>Nipa burtini</i> (Brongniart) Ettingshausen	p. 11-12, 18
Menispermaceae	<i>Palaeosinomenium venablesi</i> Chandler	p. 12
	<i>Wardenia davisi</i> Chandler	p. 12
Anacardiaceae	<i>Spondiaecarpon operculatum</i> Chandler	p. 5
Icacinaeae	<i>Iodes corniculata</i> Reid & Chandler	p. 5
	<i>Icacinicarya platycarpa</i> Reid & Chandler	p. 5
?Theaceae	<i>Hightea elliptica</i> Bowerbank	p. 12
?Family	<i>Carpolithus pusillus</i> Reid & Chandler var <i>latus</i> Chandler	p. 12-13

In addition to the above there is: an undetermined leaf from the Blackheath Beds, Elmstead, Chislehurst (Pl. 1, figs. 1, 2). Plants from this site are rare and the general features of the leaf are shown. An *Equisetum* sp. (V. 51806) from the Woolwich Beds of Dulwich (cf. CHANDLER 1964: 95, pl. 1, figs. 3-7). This strobilus from an old collection has only just come to light; although it appears ill preserved, it is crowded with pollen. *Eohypserpa parsonsi* Reid & Chandler, Sheppey is figured (Pl. 3, fig. 9) for comparison with *Daviscarpum gibbosum*. *Olaix arnensis* (Chandler) formerly relegated to *Carpolithus* can now be placed in its systematic position (see p. 11, 13). Barren foliage from Bournemouth (Pl. 12, figs. 5, 6; Pl. 13, fig. 3) formerly attributed to *Araucarites* is shown for comparison with Hamstead material and united with *Sequoiadendron fordii* (p. 38). Corrected localities for palm leaves are given (p. 13)

**SOME COMMENTS ON THE LONDON CLAY PLANTS**

The serious study of the London Clay plants dates from BOWERBANK's unfinished work of 1840. It has resulted in the accumulation of a mass of material, much of which is in the British Museum (Natural History). Some is scattered through various other Museums and Institutions and no doubt there is an appreciable amount in private collections. In spite of attempts to preserve these specimens the losses over the years through decay have been stupendous. From BOWERBANK's day onwards experiments intended to prolong their life have been tried by painting with some protective covering and by immersion in fluids such as linseed oil and glycerine to exclude air. Nevertheless, rotting black heaps with green ferrous crystals, red flocculent rust and free sulphuric acid in many containers still emphasize that iron pyrites is an unstable compound. Recent experiments at the British Museum by immersion in silicone fluid and using other techniques are now on trial. It will be many years before it can be known with certainty whether or not these techniques are permanently successful. Meanwhile the perishable quality of these fossils makes it imperative that there should be adequate pictorial records and descriptions of as many important specimens as possible.

[Publisher's note: Detailed information concerning the conservation of pyritized fossil material may be found in HOWIE (1978) and HOWIE (in press). HOWIE (in press) has recorded that many pyritized plant specimens have now survived for up to 18 years after transference to silicone fluid without further deterioration].

The continual search for the plants over such a long period of time might be supposed to have exhausted the riches of the London Clay flora. Yet although some five hundred odd species, both common and rare, have been found, entirely new material is still discovered from time to time. An especial tribute is due to the painstaking persistent efforts of Dr. H. P. WILKINSON, then Miss, at Sheppey and Mr. E.M. VENABLES and his team of helpers at Bognor. They still find many treasures and their generosity has continually enriched the National Collections. The majority of really small fruits and seeds come from Bognor partly as a result of the character of the exposures and largely as a result of the way they have been worked. Since Mr. VENABLES' discovery of the plant beds there, intensive collecting has taken place, often by sifting, whenever the state of the shore permitted. Many of these tantalizing, beautiful but tiny specimens have not yet been determined, usually because adequate knowledge of comparable Recent material is lacking. No doubt, as they are distinctive, they will eventually be named. They are therefore well worth a published record in the hope that someone else may recognize them where the writer has failed. Every shred of evidence is important as it may contribute to this end. Attention is called here to Mr. VENABLES' detailed account of the exposures and succession in the Bognor foreshore (1963: 245) which is of immense value to all future collectors.

In order to help towards a balanced picture of the plant remains, and to assist later workers to recognize them quickly for what they are, a few specimens other than fruits and seeds are included in this supplement. The true nature of such



puzzling specimens as tap roots and spines is not always obvious on first meeting them. Even when their general nature is clear it has not yet been possible to determine them precisely. They do, however, form an integral part of the flora. Such objects are nowadays frequently noticeable among the debris left by a flood as they lie stranded on the scoured surfaces of stream banks when the flood waters have subsided.

#### PROBLEMS OF PRESERVATION WITH ESPECIAL REFERENCE TO *POLYCARPELLA*

Different types of preservation have inherent difficulties and compensations. In stressing the fine preservation of cells in pyritized material, more especially of the softer pulpy tissues, CHANDLER (1964: 62, 64) failed to emphasize sufficiently the wealth of information in regard to cell structure also to be found in carbonaceous fruits and seeds. This is, in fact, implicit in the systematic descriptions of most species but it is here further stressed in a general way because of its importance as a factor in diagnosis, despite the normal absence or occasional mummified presence only of the softer pulpy pericarp in fruits. Carbonaceous specimens have two great advantages over pyritized ones in that they bear a much closer resemblance externally to living counterparts and they are more readily dissected. Even irregular fractures, whether natural or artificial, often follow, in part at least, natural planes or lines of weakness, thereby exposing vital organs such as germination valves, separate integuments, canals, placentae, etc. These are clearly shown for what they really are so that their true nature is readily understood. On the other hand the distension of the cells in pyritized specimens and their resulting hardness which allows abrasion to modify their appearance very readily, often gives them a peculiar aspect which masks the likeness to a Recent ally.

*Polycarpella caespitosa*, redescribed on p. 14 illustrates clearly some at least of the difficulties of dealing with pyritized material. At the same time it shows also some of the advantages inherent in this kind of preservation. *Polycarpella*, whose botanical position remained undiscovered for years, is now referred to the Cyperaceae as a result of new understanding of its structure. That we know the form and approximate size of its capitula is due undoubtedly to the infiltration followed by hardening of pyrites which has cemented together the component spikelets of the head. Without this process the spikelets (fruits and glumes) would have fallen apart as they have done in the abundant *Caricoidea* from the Lower Tertiary of the Bournemouth area where isolated fruits are common. In one specimen only has the carbonaceous *Caricoidea angulata* Chandler (1963: 66, pl. 9, fig. 2) displayed two closely adherent fruits giving evidence that these were borne in life in some sort of head. There was no indication of its size and shape but the mode of growth could be inferred to a limited extent from the varying forms of the separated fruitlets. Not only between fruits and glumes does the pyrites in *Polycarpella* act as a cement, but between adjacent surfaces of all parts of the fruitlets. Usually, there is a limited amount of carbon preserved within the pyrites, e.g. in cells of the calyx-like setae around each fruit; or again in the elongate testa cells. There may be a mere film of organic integument between any two almost contiguous pyrites surfaces. On exposure to air disruption may result either from decay of the carbon or from chemical breakdown of the pyrites. When this happens the cemented surfaces separate. Such processes explain why the fruits in the capitula tend to fall apart after a time; why also the capitulum of the recently found V.51634 appeared to split for no obvious reason thereby providing the natural longitudinal section in Pl. 2, fig. 4. A spontaneous break can be more informative than a man-made thin section for it shows curved surfaces and planes at varying angles simultaneously. One surface can then be traced continuously into another in a different plane nearby. Breaking caused by the sort of disintegration described above may, like fractures in carbonaceous fruits, reveal connexions between vital plant organs which would otherwise be hidden. In *Polycarpella* one advantage of pyritization is that the delicate setae with some details of their cell structure are preserved largely because they are cemented to the sides of the fruits. In the carbonaceous *Caricoidea obscura* and *C. angulata* the setae are missing although the undoubted affinity of these species indicates that they must originally have been present. An initial difficulty in the understanding and determination of *Polycarpella* was due to the apparent branching of some of the setae (REID & CHANDLER 1933: 486, pl. 28, figs. 17, 18). It is now clear that these had been twisted, bent and closely cemented together thereby simulating branching. Another difficulty arose from the extreme thinness and tenacity of pyrites film between testa and seed-cast, locule wall and testa. Such films, unless some measure of disintegration releases them, can be very difficult to separate without destroying the delicate evidence they conceal. Hence REID & CHANDLER's initial difficulty in interpreting the structures and organs of these tiny seeds. This in its turn explains their failure to recognize the family Cyperaceae. The removal of a film of pyrites between internal seed-cast and testa has now shown that the large circular apical scar impressed upon the seed-cast is its chalaza, not as they thought its hilum. Its true nature is further confirmed by the arrangement of its cells. The apparent wedge-shape of the seeds has only lately been understood as caused by apico-lateral flanges of pyrites casts of the compressed locule cavity. The close adhesion of exocarp and endocarp and the abrasion of the apices of both of these heavily pyritized envelopes posed a further problem only resolved when the capitulum of V.51634 showed sharply defined planes of separation between them. Even so, the understanding of *Polycarpella* might not have been possible without the experience of the Bournemouth Cyperaceae acquired since 1933. In these carbonaceous specimens not only was the exocarp



distinct and easily detached from the endocarp but the latter was frequently shed as a well-defined oburceolate structure, the nature of which was clear from experience of living Caricoideae. Here the plug closing the basal aperture of the endocarp and bearing the seed on its upper surface could not be overlooked as representing placenta and hilum. The flexible semitranslucent testa was often separated by natural maceration from the locule lining and the organs of the seed were sometimes clearly visible on it. The carbonaceous tissues showed to perfection the spongy parenchymatous character of exocarp and endocarp with thin walled uniform equiaxial cells having large lumina as in the living. The pyrites filled tissues of *Polycarpella* on the contrary have lost the spongy appearance and look so "solid", that they do not obviously resemble Cyperaceae.

### THE EFFECTS OF A DIFFERENT MODE OF PRESERVATION AS ILLUSTRATED BY CERTAIN SPECIES

It is not always easy to recognize a species common to two deposits when the preservation in the two cases is of an entirely different kind. For many years the full effects of preservation were not clearly perceived. Some attention was given to the matter in 1964 (CHANDLER: 67: 118, 123, 125) when the reasons for the different appearances were discussed. By that time it was clear that a number of pyritized London Clay species were identical with similar but smaller, because shrunken, carbonaceous ones from younger beds. Among these were *Sequoia couttsiae*, *Nipa burtini*, *Spondiaecarpon operculatum*, *Natsiatum eocenicum*, *Rhamnospermum bilobatum*, also perhaps *Palaeophytocrene foveolata* and *Mastixia cantiensis*. In the rarer carbonaceous London Clay material from Nursling the connexion was more apparent in the case of *Anemia poolensis*, *Palaeococculus lakensis*, *Vitis pygmaea*, *Vitis obovoidea*, *Cleyera? stigmosa* (described by CHANDLER in 1964 under the name of *Myrtospermum variable*), *Ehretia clausentia*; probably also in *Tinospora excavata*.

An endocarp of *Iodes corniculata* from Sheppey (V.51158) is shown in Pl. 5, fig. 14. It so closely resembles the Lower Bagshot *Iodes acutiformis* that their identity, always suspected, must now be regarded as established. *I. acutiformis* therefore becomes a synonym of *I. corniculata*. The difference of size (Bagshot endocarps 6 by 3.5 to 4 mm; V.51158 9.1 by 6 mm., 3 mm. thick) is fully accounted for by shrinkage (cf. CHANDLER 1962: 95). The carbonaceous coat in V.51158 was preserved (it has now flaked away as a result of treatment for preservation). Although the sharpness of the surface ridges was slightly reduced thereby, the attenuated form of the endocarp and its relatively narrow outline agree with the Bagshot endocarps. The horn-like projections flanking the style are somewhat abraded and crushed.

V.51161 (Pl. 5, fig. 15) a rare endocarp of *Icacinicarya platycarpa* from Sheppey with carbonaceous coat preserved, only slightly smoothed and polished by abrasion, is 22.5 by 16 mm. (7 mm. thick). The obscure network of ribs is visible on the worn surface; the "horns" flanking the style are obscure. They lie on the right side of the apex in the figure. The possible connexion with this and the smaller carbonaceous *I. inornata* (Lower Bagshot) must still be borne in mind.

An unusual subglobular endocarp of *Spondiaecarpon operculatum* from Warden, Sheppey, is depicted in Pl. 5, fig. 10. Although only 7 mm. long, 6 mm. broad, it does not appear to be separable from the original Bognor material.

*Palaeosinomenium pulchrum* was the name given to carbonaceous endocarps from Nursling (CHANDLER 1961: 329, pl. 33, fig. 5-7). They can now be referred to *P. venablesi* (CHANDLER 1961: 159, pl. 15, figs. 9-13) so the name *P. pulchrum* becomes a synonym. It was separated in the first place because the endocarp is more obliquely curved than in *P. venablesi* and there is a relatively smaller concave area between the limbs of the curved seed. It is also smaller: *P. pulchrum* 3-3.25 by 2.2 mm. *P. venablesi* 4 by 4.75 mm. Now it is clear that a difference in size of this degree is of little account in comparing a carbonaceous with a pyritized specimen, the former always being shrunk, the latter distended. Contraction of the carbonaceous tissues also explains the smaller concave area. The small pyritized specimen (V. 30578a; Pl. 4, fig. 1) 3 by 2 mm. also supports the revised opinion for its concavity is even smaller than in the Nursling seeds and its obliquity is as great.

### HANDICAPS TO THE COLLECTION OF CARBONACEOUS FORMS

One major drawback in working on carbonaceous plant remains in this country is that there is not much chance of finding them concentrated by sea action as in the case of pyritized London Clay specimens. In the London Clay the sea is a remarkably effective assistant. The best exposures are coastal so that the deposits are subject to a perpetual preliminary sifting by this natural agency. Partly because of this the plant lists are greater than those for the carbonaceous fruit deposits. Rough treatment by waves, while it may abrade pyritized surfaces, breaks up and destroys carbonaceous specimens. The would-be collector must therefore discover the seams in the cliff section and sift for himself so that what can be collected is limited in amount. While there is nothing to prevent the enthusiast from combing a beach littered with

pyrites nodules indefinitely, there is everything to hinder efficient excavation of cliffs. In a small densely populated country like Britain with its ever growing urbanization the practical difficulties of obtaining large quantities of carbonaceous carpological material are great. The palynologist who works with smaller samples is undoubtedly better off. Gone are the days when men of some wealth and leisure, like J. STARKIE GARDNER, could employ labourers to make large scale excavations in unprotected cliffs thereby obtaining such masses of leaf and other plant remains as he desired. To collect two or three tons of material for sifting in the laboratory can be carried out in America but not here. We lack the practical facilities and financial resources for work on such a scale. Such material as can be collected must therefore be used to the full. Even when a very few specimens only are found of a particular kind, we cannot afford to ignore them.

### REASONS FOR FAILURE TO IDENTIFY FRUITS AND SEEDS

We may explain the failure to determine certain fossil fruits and seeds as due in the main to three causes.

First and foremost is ignorance of the living, especially of the smaller, seeds.

Second, there are innumerable cases where the fossils do not afford sufficient evidence to indicate relationship.

Third, there is the undoubted existence of some extinct types which are not sufficiently comparable with any living forms to provide a clue to their closest surviving relatives, perhaps because they are without readily recognizable family characters. The writer believes that all or almost all plant families in the Lower Tertiary may be living today whereas many genera may now be extinct.

Last, but by no means least, is failure to interpret structures correctly (illustrated by *Polycarpella*). Such failures probably account for quite a number of Tertiary genera now regarded as extinct. That they certainly do not account for all such can be demonstrated in a small family like the Menispermaceae where most Recent genera are known. Even in this and other similar instances it must be borne in mind that knowledge of the Recent fruits and seeds is never 100% complete for there are still genera which have no known fruit or of which none exist even in a great Herbarium like that of Kew. There is ever present the interesting possibility of making some new and illuminating discovery.

### SOME DIFFICULTIES IN THE NAMING OF FOSSIL SPECIES

The problem of naming Tertiary plant remains is an old one, although in most, perhaps in all families a large number of genera are still living. Evidence available to palaeobotanists is so restricted as compared with what the botanist can use that for many years scepticism was rife about the possibilities of determining such detached organs as fruits and seeds. The late Mrs. Clement REID often told the writer that 40 or 50 years ago many botanists were unable to accept such organs as serious evidence of affinity. Gradually, by the fortunate accident of having started with Quaternary and younger Tertiary deposits, the scepticism gave way before indisputable facts and it was eventually fairly widely acknowledged that even in older Tertiary beds, given a sufficient acquaintance with living material and enough care in the examination of well preserved fossils, reliable determinations can be made. Among the believers were Arthur HILL and W.B. TURRILL who interested themselves in the work and at Kew did much to make available Recent material for comparison.

Fossil leaves, never studied to any great extent in this country, have elsewhere proved their value. Not only taxonomically but as indicators of the conditions under which they grew they have an important contribution to make. This is one reason for including here the unnamed leaf from the Blackheath Beds in Pl. 1, figs. 1 and 2. The gradual acceptance of such detached plant organs as evidence probably paved the way for the readier welcome accorded to pollen research which has increasingly occupied the attention of students of plant remains during the past thirty years or so.

In regard to fruits and seeds the old scepticism still persists in certain quarters in a modified form which displays itself in a reluctance to use the actual Recent botanical name for the fossil representatives of living genera, however well the relationship can be demonstrated. This attitude is tantamount to erecting an arbitrary wall between fossil and living. Hence the insistent use of *Nipadites* as opposed to *Nipa* which reappeared in a paper by STOCKMANS (1936).

There are, of course, innumerable cases where the relationship cannot be demonstrated as convincingly as in *Nipa*. Sometimes, for this reason, form-names are a necessity. When used they constitute a confession of partial failure as in the case of *Leguminocarpon*, *Leguminosites*, *Rutaspermum*, *Euphorbiospermum*. Names like these, while signifying a family alliance, indicate that the generic affinity has not yet been traced. It may be because the evidence obtainable from the fossils is insufficient but probably most often it is because the amount of work on living material necessary to establish the closer relationship is prohibitive. This applies especially in the case of the larger families like Lauraceae and Leguminosae. The thorough study of these from the standpoint of fossils would fill a life-time of research and yield



results of much interest. Unfortunately time is a factor in short supply in human affairs.

Whether dealing with the richer vegetation of the London Clay or the lesser carbonaceous floras of the Hampshire basin one problem must be faced and a decision reached. It is that whereas some plants like *Nipa* and *Mastixioideae* may occur in rich profusion, others are represented by one, two or a small number only. In deciding what use to make of such sparse material it is necessary to bear in mind that the rarity of a fossil does not necessarily indicate that it played an unimportant part in the flora to which it belongs. Sometimes, no doubt, this is the correct explanation but often it may merely signify that the plant grew where it had limited opportunities only of reaching the water which was the means of transport to the site where the remains were to become fossilized. This point has already been discussed by CHANDLER (1964: 61). It is again stressed to emphasize the fact that we cannot afford to ignore such evidence although to the Recent botanist and probably some palaeobotanists the iniquity of basing a species (or even genus) on very limited material, perhaps one specimen only, may be very great indeed. The propriety of giving such sparse material names rests on the answer to one question. Would the fossil be recognizable if found again? If it would be recognizable under the same conditions of preservation, justification for naming is clear. If further there is reason to think that allowing for complicating effects of different types of preservation, it would still be recognizable in a different deposit, the case for diagnosis and naming is very strong indeed. If it is justifiable to take this action in the case of one species, then it is also legitimate to take it in the case of a second, a third or a tenth where the characters are equally clearly defined. Justification for acting thus can be illustrated from a number of actual cases as follows:

The distinctive London Clay genus *Daviscarpum gibbosum* (Chandler 1961: 157, pl. 16, fig. 5) was based on one specimen at first. It possessed the essentials for recognition again when it turned up once more a few years later (p. 20, pl. 3, figs. 6-8). In this case the essentials are a marginal ribbon-like locule of horse-shoe shape as in the *Cocculineae*. A central inflated area between the limbs of the locule formed by an outgrowth of the locule wall which covers and conceals the concave region between the limbs on each side of the endocarp.

The examination of the second specimen revealed that *Daviscarpum* was related to *Limacia*, *Hypserpa* and the fossil *Eohypserpa* but that it differed from all three in the manner described on p. 21. Further specimens, if and when they are found, will usefully show the range of variation of size and possible variation of form, but even without this knowledge this menispermaceous endocarp constitutes a well characterized genus in its own right.

The beautifully ornamented *Natsiatum eocenicum* Chandler, now known from carbonaceous and pyritized specimens, was originally based on two endocarps found prior to 1925 in the Lower Headons of Hordle. They so closely resembled *Natsiatum*, a living species from Mt. Omi in China, that their affinity was unmistakable. It was afterwards confirmed by detailed study. The same species has since turned up in the Woolwich and the Reading Beds, the Blackheath (internal calcite casts) and Oldhaven Beds (casts in sandstone), the London Clay (pyritized), the Lower Bagshot (preservation exactly as at Hordle) and the Bournemouth Beds (as an external impression).

Again the carbonaceous *Phellodendron costatum* Chandler first found at Hordle, represented by one seed, has a similar history. Its close relationship to the Recent *Phellodendron* (Rutaceae) is guaranteed by its form (somewhat more inflated than any species seen), its strap-shaped hilar scar, short raphe and large internal circular aperture at the chalaza. Confirmation is provided by the surface ornamentation. Whether it is eventually left in the genus *Phellodendron* itself or transferred to one closely allied, it is a recognizable seed whenever it is found. After many years other specimens were collected at Hordle (CHANDLER 1963: 92, pl. 14, figs. 27, 28) and in the Lower Bagshot of Arne (CHANDLER 1962: pl. 10, fig. 1) and at Sandbanks (CHANDLER 1963: pl. 14, figs. 24, 25). It was also discovered as an internal cast with external impression in the Reading Beds (CHANDLER 1961: 75, pl. 7, figs. 10, 11).

### SPECIAL CASES TO ILLUSTRATE SPECIES DISCRIMINATION

Whereas cases like the genera quoted above are clear cut, there are many which present the carpologist with difficulty when attempting to discriminate between fossil species. The family Magnoliaceae is a good instance not only in fossil but in Recent material as well. When seeds only are available the problem of discriminating between species exists. If, as rarely happens, the seeds are abundant, a number of characteristics can be used in an attempt to distinguish between species, viz. size and shape, more especially the relationship between length and breadth; the form of the chalazal region in profile whether straight or curved; the degree of curvature and its direction or the flatness of one or both valves of the seed; the thickness, roughness or smoothness of the hard inner integument or sclerotesta; its detailed structure at the chalazal end ("heteropyle" of KIRCHHEIMER) and the character of the funicle; the form and proportions of the oval internal chalaza scar; the size and thickness of the cells of the sclerotesta.

While some Recent *Magnolia* seeds like those of *Magnolia kobus* have a highly characteristic appearance, in other species this is not the case. The small seeds of *M. wilsoni* and *M. parviflora* in which there may be no marked difference between



length and breadth, are sometimes at least so alike that in two gatherings in the Reid Collection it is virtually impossible to sort them on superficial appearance alone although the few seeds of *M. wilsoni* are slightly thicker in the plane of symmetry than *M. parviflora*. As is now well known there are American species with seeds which are intrinsically longer than broad, i.e. not through facetting caused by mutual pressure of adjacent seeds during growth which reduces breadth. They differ definitely from some of the Asiatic species in which the seeds are markedly broader than long even when facettted by growth pressure. Within this last group it is not necessarily easy or possible to separate species for almost identical seeds can be found, for instance, in *M. soulangeana* and *M. lennei* even when represented by small gatherings only.

KIRCHHEIMER (1957) made a study of certain living forms as a result of which he expressed the opinion that the common living species cannot in general be separated by their seeds which are polymorphic. He also noted that transitions occur between various forms in regard to the cell-structure of the sclerotesta. He followed up his study of Recent *Magnolia* by an investigation of Magnoliaceae from the Brown Coal. He was fortunate in having numerous fossil seeds gathered on restricted sites near which they had clearly grown together in the same stand of plants. This being so he was able to discover the possible variations of his species and to give a satisfactory diagnosis. On the strength of the evidence he was able to define a few Brown Coal species and even new genera of Magnoliaceae.

In the London Clay where *Magnolia* abounds the problem of discrimination between species is greater than in the Brown Coal. The seeds have been transported by river currents and carried out to sea, various *Magnolia* species being mixed together with debris of other plants. There is no chance here so far as can at present be judged of finding together large assemblages of *Magnolia* seeds from a single site which must have accumulated more or less *in situ*. The seeds, derived presumably from many sources, have been separated, sorted and reaccumulated by the sea. Further the great majority of specimens have lost most or all of the sclerotesta or at least have lost it immediately on exposure to air. Most specimens are therefore casts of the seed-cavity usually showing the tegmen cells, the position of the micropyle, form and size of the internal chalaza. Some show an adherent film of pyrites displaying equiaxial cells of an inner layer or layers of sclerotesta. Some few have the sclerotesta virtually complete in which case it is often impregnated with pyrites giving temporary durability.

While there are in the London Clay seeds so outstandingly different from the great majority that they must undoubtedly represent distinct natural species, such forms are rare. When seen they can be picked out because of well-defined peculiarities of size and shape. Such are *Magnolia longissima* (Bowerbank) (length 6.25 mm; breadth 16 mm; thickness 4.25 mm). The thickness of the somewhat abraded testa which remains in part is 0.7 mm. Again there is *Magnolia gigantea* Chandler (length 9.5 mm; breadth 15 mm; thickness 7 mm, with testa preserved but not seen in section). A well characterized group of seeds was named *M. angusta* by REID & CHANDLER. They were consistently longer than broad with a narrow elongate form somewhat resembling some of the American species. As they were assembled from far and wide at different times there is no guarantee that more than one true species of this type is not included under the name. *Magnolia lobata* (Bowerbank) is a distinctive, smooth, saddle-shaped small seed, sub-reniform in outline, distinctly concave on the raphe side and at the chalazal margin (length 3.6 to 6 mm; breadth 5.5 to 8 mm; thickness 2.4 to 3 mm.). The testa is abraded so its true thickness is not known. There may be somewhat similar seeds showing slight variations gradually merging through a graded series into something much less distinctive. The question then arises: where should the limits of this species be drawn? *Magnolia subcircularis* Reid & Chandler is approximately equal in length and breadth, thinner in the plane of symmetry (length typically 4-6 mm; breadth 5.2 to 6 mm; thickness 1.75 to 2.5 mm with thin testa only about 0.15 mm thick). The form is ovate to roundly triangular or subcircular; the concavity at the chalazal end is very slight; both broad surfaces are slightly convex. It appears to stand out as distinct from other species.

Among the confusing numbers of seeds which are about as broad as long there are other distinctly broader than long types in addition to the large ones already mentioned, viz. *M. oblonga* Chandler (length 5.5 to 6.25 mm; breadth 7.25 to 10 mm; thickness 2 to 2.5 mm), the cast is slightly hollowed on the raphe side with long straight outline at the chalaza and the testa is missing. *M. davisii* Chandler (length 7.5 mm; breadth 11 mm; thickness 3.5 to 4.5 mm) has its smooth testa more or less complete.

Other seeds such as *M. rugosa* Chandler with a distinctive ridged surface like that of the Recent *M. tripetala* must represent a different species from the smooth types with shining sclerotesta.

While, therefore, some few typical well characterized "species" can be recognized when met again, there are in addition large numbers of *Magnolia* seeds from the London Clay which, when laid out side by side, are difficult to sort and classify; marginal forms may link one with another. There is the modifying effect of well-defined facetting when two seeds have been in close proximity in a fruit. Starting optimistically with comparatively few specimens which were survivors from the BOWERBANK Collection plus a few newly acquired, REID and CHANDLER divided the seeds into a few distinct "types" or "species". Now, in the light of increasing experience when more and more seeds have been seen as



each succeeding collector has added his or her contribution the whole situation appears to be beset with far greater difficulty than was formerly perceived. It is clumsy to have to refer back, when working to *Magnolia* sp. after *Magnolia* sp. unnamed. So as a matter of practical convenience, it may be useful to group seeds where possible into varying "kinds" or "types" even when it cannot be stated with certainty that this one or that is a true natural species. The alternative position is to retain as *Magnolia* spp. all but a few outstanding seeds. It still seems possible that given an abundance of the seeds of a really large representative collection of living species of *Magnolia* some means of distinguishing between may yet be found provided that unlimited time and patience are also available. Moreover means of discrimination as yet not recognized may come to light in the future. The really important point in regard to the London Clay *Magnolias* is to realize the tremendous part played by this essentially upland genus. So far only one convincing specimen of the lowland *Talauma* has been found.

It is a pleasant contrast to turn from Magnoliaceae to the simple monotypic genus *Stratiotes* of the Hydrocharitaceae found throughout the Tertiary and Quaternary from the Bournemouth Beds upwards. When as in this case the living species has certain clearly defined characteristics which can be traced with gradual variations through a wide range of fossil forms of different age it soon becomes apparent which of the characters are of specific importance. The different combinations of small changes imposed upon the general ground plan of *Stratiotes* in the species are comparatively easy to detect. Size and shape, whether long and narrow, broad and squat, more or less inflated, the breadth of the keel which carries the raphe, the degree of development of the collar which surrounds the micropyle, the length and course of the raphe; the direction of the micropylar canal; the degree of ornamentation of the surface, the coarseness of the surface pitting ("cells"); the form of the cells inside the keel, taken together provide a relatively easy way of separating most species known if they are well preserved and the seeds well developed. As a rule, if *Stratiotes* occurs at all it occurs in abundance thanks to its gregarious habit in life. The numbers of seeds available on this account afford valuable evidence as to the specific importance of the characters used in diagnosis. In all such cases (cf. *Nipa*) allowance must be made for small stunted abortive or immature seeds or fruits which occur when a capitulum of fruits or many seeded fruits are under consideration.

One more family which is abundant in the geological record in certain strata may be considered, viz. the Vitaceae. It is sometimes regarded as a difficult family for the discrimination of species from the seeds alone but is easier and more satisfactory at least in many instances than the Magnoliaceae although it too has many Recent species. If the seeds of a large single gathering of a particular species of Recent *Vitis* are laid out side by side it becomes apparent that while individual variations exist these are confined within certain definite limits appropriate to that particular species. Long experience indicates that the chief points to be observed in attempting specific determination are the following: size, shape, form of the chalazal scar and its position on the dorsal surface; the mode of transition of the raphe into the chalaza; form, width and position on the ventral surface of the longitudinal infolds (ruminations) in relation to the median line or raphe ridge and the extremities of the seed, also their depth; degree of attenuation of the seed-base; presence or absence of an apical emargination; contours of the testa surface, whether lobed, smooth, sharply radially ridged or slightly fluted; lesser superficial features of the testa; structure and thickness of the hard testa layer. While there may be a considerable variation of size and outline in a living species there are not, generally speaking, outstandingly large seeds in a medium-sized species. If extra small ones are present they may be immature or the results of crowding in a berry or derived from an ill-developed berry. The chalaza normally occupies the same relative position in any given species and approximates to a certain standard in the matter of size. The infolded ruminations may be convex or concave to the raphe ridge or straight and parallel with it, or sub-parallel and divergent upwards. They may be short or long reaching to the margin at one or both ends and, although showing some variation, this again appears to be confined within certain limits in any one species. A smooth-seeded vine may display fine puckerings around the chalaza but marked rounded lobes or sharp angular radiating ridges are indicative of different species. Again it is the total characters combined which must be used if a diagnosis is to be attempted. Certainly very often it seems that the particular combination is so distinctive in the Recent that even a single seed may serve to indicate a particular species. The same appears to be true of fossil material at least as found in a given deposit. When, therefore, a well-defined combination of characters is recognized, good grounds for diagnosing and naming a species may exist even although the fossil material is sparse. This does not mean that mistakes will never occur but the conferring of a name under such conditions helps to impress upon the mind the individuality of a species. It is easier on the whole to amalgamate two or more species should later work show that they ought to be merged, than to keep unnamed variations in mind or to carry out repeated scrutinies of tubes of unsorted and unnamed specimens. Their variations in this case will have left no clear impression. With the limited material so often at palaeobotanists' disposal it is important to use to the full such information as it can yield and to make it available by a published record.

The London Clay and Lower Bagshot Beds have provided a considerable number of Vitaceae species based on seeds which so far as can be judged are distinct. In the Lower Bagshot some of them are represented by abundant specimens.



When this occurs the limits of the species concerned can be widely drawn. In the London Clay individual seeds of a species are not usually very numerous. But in both deposits there are highly distinctive looking seeds which show such combinations of characters as should make them recognizable again, sometimes "even at a glance". Here perhaps, it may be justifiable to mention that the handling and comparison of such fossils over the years does greatly assist in dealing with problems of this kind. It is regrettable that an instinct for sensing differences based on long experience, cannot be conveyed by the printed word or formal description.

A good example of a recognizable species at least when the preservation is carbonaceous is *Vitis pygmaea* Chandler. It was first recognized in the Bournemouth Beds at Sandbanks, then later in the Lower Bagshot at Lake, the Bournemouth Beds of Branksome Dene and successively in the Lower Bagshot of Arne and the London Clay of Nursling. These smooth small daintily stipitate seeds with prominent small chalaza and highly characteristic ventral infolds are described in detail by CHANDLER (1961: 77, 333, pl. 8, figs. 6, 7; pl. 34, figs. 5-11; 1962: 100, pl. 14, figs. 5-31). Prolonged handling of the species now makes it clear that V.29652 from the Woolwich Beds of Tooting Broadway, Surrey (CHANDLER 1961: 78, pl. 8, fig. 6) is indeed the same as was at first provisionally suggested. Further, an imperfectly known specimen (V.22791) differently preserved in calcite in a cement stone in the London Clay of Assington, Suffolk, a rare locality for plants, designated *V. minuta* Reid & Chandler (1933: 381, pl. 19, figs. 3, 4) is in all probability *V. pygmaea* as well but partially disguised by a different type of preservation. As joint author of this *V. minuta* and author of *V. pygmaea* the writer now suggests that *V. minuta* be transferred provisionally to the well-known, well-represented, and well-defined species *V. pygmaea*. Nevertheless, its original separation helped to keep it in mind during later work.

*V. goodharti* (CHANDLER 1962: 101, pl. 14, figs. 32-34) from the Lower Bagshot of Lake is such a clearly defined form that had there been one seed only it would be unmistakeable when encountered again. In actual fact, it is an abundant species not as yet found elsewhere. Equally outstanding and well-characterized is the laterally flattened *V. platysperma* (CHANDLER 1962: 104, pl. 15, figs. 1-5). *V. triangularis* is well-defined, represented by a number of seeds found closely associated in a limiting exposure at Arne in the Lower Bagshot (CHANDLER 1962: 105, pl. 15, figs. 3-13). *V. arnensis* is now recognized provisionally in the London Clay of Bognor (p. 27, pl. 6, figs. 1, 2). *V. glabra* is another clear-cut Lower Bagshot form (CHANDLER 1962: 103, pl. 14, figs. 49-53). Of the Bagshot species based on single specimens *V. cuneata* and *V. lakensis* are distinct (CHANDLER 1962: pl. 14, figs. 45-48). *V. ambigua* and *V. symmetrica* leave scope for further investigation (CHANDLER 1962: pl. 15, figs. 6, 7, 27, 28). The latter is almost certainly a *Parthenocissus* rather than *Vitis* in the strict sense. *V. excavata* is so peculiar that although imperfect (CHANDLER 1962: pl. 15, figs. 29, 30) it cannot be ignored and is compared with a somewhat similar seed from the London Clay (p. 27, pl. 6, figs. 7, 8).

It is heartening to find that some Vitaceae from the London Clay based on one or two specimens only have been recorded again from the original or from new localities. These are described on pp. 17-28, pl. 6, figs. 1-20. Among them, *Vitis magnisperma* invites comparison with *Vitis lakensis* (mentioned above) from the Lower Bagshot, on account of the unusually large size of both. *V. lakensis* is 8.75 by 6 mm., and *V. magnisperma* 8.25 by 6 mm and 8.5 by 6.5 mm. In comparing the two it is essential to remember the extensive measure of shrinkage of carbonaceous seeds which may lose up to half of their linear dimensions in drying. The pyritized seeds of *V. magnisperma* on the contrary are fully distended rather than shrunk because of the pyrites which fills all cavities in the seed. Such being the case the original size of the carbonaceous *V. lakensis* must have been in the neighbourhood of 13 to 16 mm. in length and correspondingly broad. To this consideration may be added the peculiarly rough almost scaly surface of *V. lakensis* in contrast to the smooth surface of *V. magnisperma*. One other character of some significance is the closer approximation of the shorter ventral infolds of *V. lakensis* with an even slighter convex curvature towards the very narrow raphe ridge. The differences discussed above seem to confirm that the two are separate species.

Other instances where the finding of further material has supported the previous determination based on limited material can be picked out from the published work. The confirmation of their character is perhaps especially significant when the seeds come from widely scattered localities as in the case of *Vitis bracknellensis* Chandler (1961: 250, pl. 25, figs. 1-5), *Vitis subglobosa* Reid & Chandler (1933: 379, pl. 18, figs. 34-37; CHANDLER 1961: 245, pl. 24, figs. 14-17); *Vitis obovoidea* Chandler 1961: 247, pl. 24, figs. 25-28, and p. 334, pl. 34, figs. 12, 13.

That difficulties do arise from time to time and mistakes are made in palaeobotanical work is not surprising when botanists working with Recent and usually more complete material have their own difficulties in the identification of Herbarium specimens. That this is so is apparent from many Herbarium sheets. Species and even genera have sometimes been wrongly named and the names later corrected. Even in a family like the Menispermaceae with characteristics which mark it out from all others, confusion has often occurred, e.g. in species of *Tinospora*. In fossil work, these too are difficult especially when the palaeobotanist is sometimes dealing with smooth internal casts of the endocarp and at other times with the carbonaceous endocarp itself either with or without a cast. The external surface may be smooth



or variously tubercled or rugose. Until the living plants are reliably determined in all cases an element of uncertainty may from time to time be introduced in attempting to name related fossil fruits and seeds which have been matched with living plants of uncertain affinity.

Nevertheless, although our present state of knowledge is mixed with some measure of ignorance and error, there are rewards when clearly defined forms are found. Such, for example, are the two species of *Atriaecarpum* (Menispermaceae), *A. venablesi* and *A. deltiforme* (p. 22, pl. 4, figs. 4-10) between which there can be no confusion. In the older Tertiary at least it is the genera rather than the species which are most informative.

#### A FEW PLANTS ALREADY FULLY DESCRIBED WHICH ARE NOT INCLUDED AMONG THE SYSTEMATIC DESCRIPTIONS

Some of them require small additions of fact, others call for further discussion or comment for some definite reason. The species formerly described as *Carpolithus arnensis* can now be referred to the Olacaceae as *Olaix arnensis* (Chandler) (p. 13). The localities of certain palm leaves have been corrected (p. 13). *Nipa burtini* (Brongniart) Ettingshausen, V.40261, is one of the rare examples of a fruit found *in situ* in the Sheppey Cliffs on the Sheerness side of Minster where a large piece of clay had broken from the cliff. Although flattened and abortive it had a well-preserved umbo and carbonaceous epicarp showing rounded equiaxial cells, about 0.038 mm in diameter, near the apex of the fruit. Lower down the cells become more elongate. This fruit closely resembles in size and appearance one of BOWERBANK's figures (1840, pl. 1, fig. 11) which was about 80 mm long, 40 by 18 mm in transverse diameter.

The supposed absence of the epicarp in the majority of specimens of *Nipa* is often due to the readiness with which the carbonaceous surface flakes away on exposure to air and drying. The small equiaxial cells of the epicarp have now been seen in a considerable number of cases. They are common at the upper end of very small young fruits from Sheppey and were present in a tiny immature fruit from Selsey (CHANDLER 1961a: 34: 1961: 1-33). V.51144 from the Upper Fish Tooth Bed, Bognor, has, or had, a well-preserved epicarp. V. 33811 is the apex of a fruit from a new site, found by workmen below Hillgate House, Ludgate, in the City of London.

TRALAU (1964) gives a valuable comprehensive survey of the living and fossil genus, using the spelling *Nypa* after VAN WURMB. The usual English custom has been to adopt *Nipa* following THUNBERG. TRALAU affirms that the fossils belong to the living genus and are autochthonous in our latitudes but he places all known records from whatever locality under the general title *Nypa aff. fruticans*. He regards it as quite unreasonable to assume that any of the fossils are identical with the single living species but is reluctant to separate them into fossil species on the available evidence.

He comments (1964: 21) that "If the seed sulcus should be absent more frequently in fossils than in the present day population, this character could be regarded as a specific difference", but he had not himself seen, so he believed, enough material to justify the expression of an opinion. The absence of any such deep sulcus as that in the living is a constant feature of all fossil *Nipa* seeds seen by the writer whether from the London Clay or from Bournemouth, although there may be comparatively few seeds represented at present in the British Museum (Natural History). Over the past forty years innumerable London Clay specimens have been handled and returned to finders while some have decayed. At Bournemouth, seeds isolated from their fruits were formerly very common and easily extracted but being preserved in a soft sand they were difficult to keep permanently. In 1933 REID and CHANDLER were under the necessity of convincing an unbelieving earlier generation that *Nipa* (Recent) and *Nipadites* (fossil) were one and the same genus. Intensive search was therefore made in an attempt, which failed, to demonstrate the presence of a deep sulcus in the fossils like that of the living. Large numbers of seeds were examined then, and many more during the thirty years which followed. The deepest sulcus ever found was that figured by REID and CHANDLER (1933, pl. 2, fig. 4) again figured by TRALAU (1964, pl. 4, fig. 3). But the shallow broad groove here present is in no sense comparable with the deep, long, parallel-sided furrow of living *Nipa* (CHANDLER 1954, pl. 11, fig. 12). It is associated with an incomplete conspicuous septum projecting into the locule from the carpel wall. Even shallow furrows are comparatively rare in the fossil seeds, many merely showing slight irregular flutings or undulations of the surface. REID and CHANDLER therefore interpreted the lack of a deep furrowed seed as a specific character of *Nipa burtini* due to the virtual absence of the corresponding incomplete septum. The Belgian specimens also appear to lack this feature.

The Palaeocene seed from Pernambuco, Brazil, described by DOLIANITI (1955: pls. 1-4) differs from *N. burtini* in having a marked deep furrow very like that of the living *N. fruticans* but, if the specimen is typical, it does not extend so far towards the apex as in the living species.

TRALAU does not mention the very large *Nipa* fruits from Selsey, Sussex, equal or almost equal in size to the Belgian and French examples.



As regards microfossils there are now a number of pollen records. TRALAU accepts those from the Pliocene of New Zealand, the Eocene of Borneo, the Eocene of the Ukraine and the Dorog Basin, and the Upper Eocene of Er-oil-anduz in Turkmenia. To these must now be added the London Clay records from the Isle of Wight (MA KHIN SEIN 1961). TRALAU rejects pollen described by SEDOVA (1956: 274, pl. 5, figs. 2-4) (also see in TAKHTADZHYAN 1963, 15, p. 631, figs. 395-397, pl. 30, fig. 9) from the Far East Maritime Provinces of the U.S.S.R. (on the River Mayche (Mykhe) ex lit. P.I. DOROFEEV) both on account of the structure of the grains depicted and because the age of the beds is Oligocene. The authenticity or otherwise of the record at such a period as far north as about 45° latitude is of importance, so Professor P. I. DOROFEEV kindly pursued the matter a stage further at my request. In a letter dated 31.12.1964, he reported that A.N. GLADKOVA (whose acquaintance with *Nipa* pollen is fully guaranteed by her Er-oil-anduz paper: GLADKOVA 1962: 579, pl. 1-5) is of the opinion that this pollen from the Far East is really *Nipa*, an opinion shared by two leading Russian palynologists Veronica U. SAUER and Nataly D. MTSCHEDLISHVILI. DOROFEEV adds that the pollen-complex of the Lower Oligocene of Ussuriland described by SEDOVA (1956) is an interesting one including warm temperate deciduous plants, together with Paltavian (Ukraine) elements such as Anonaceae, *Nipa*, *Trachycarpus*, *Dicksonia*, *Cyathea*, *Acrostichum*, *Lygodium*, *Danaea*. Very characteristic too are *Podocarpus*, *Dacridium* and *Ephedra*. But by Miocene times South Ussuriland had a temperate flora (letter 17.3.64). DOROFEEV reaffirms that the age of the beds with *Nipa* is Lower Oligocene and that there are no Eocene deposits there in S. Ussuriland. The associated plants suggest that the record of *Nipa* is certainly not impossible. The presence of so many Paltavian elements in the Lower Oligocene so far north as about latitude 45° is of profound interest. It suggests that the maritime areas of the Far East provided conditions where part, at least, of the Paltavian flora could survive later than it did in Europe. Possibly the boundary with the Turgaian province then lay at this latitude in Eastern Asia in the Oligocene although by Miocene times it had withdrawn further south.

A smaller endocarp (V.51640) of the species *Wardenia davisii* (CHANDLER 1961: 138, pl. 8, fig. 16) which was based on one seed only (V.29838) is shown in pl. 4, fig. 2. Its dimensions, when perfect, were 4.25 by 3.5 by 1 mm. The maximum width of the central concavity between the limbs of the horse shoe ridge was 2.5 mm. and that of the marginal rim beyond the ridge 0.75 mm. A very small but especially beautifully preserved carbonaceous endocarp is shown in pl. 4, fig. 3. It may have come from the tip of an inflorescence and unfortunately has now decayed. The dimensions were 2.75 by 2.75 mm; maximum width between the limbs was 1.5 mm; the width of the marginal rim 0.5 mm. The horse shoe ridge, well shown in the figure, bore conspicuous nodules on its inner curve. They are less obvious in the larger endocarp in which they are less developed than those of the outer curve of the ridge. The same accentuated development of the nodules on the inner side can be seen in a small endocarp of *Palaeosinomenium venablesii* (Pl. 4, fig. 1) in contrast to the development on the two sides of the ridge in larger typical examples (cf. CHANDLER 1961, pl. 16, figs. 9, 10). Both specimens of *Wardenia* here illustrated are from Bognor, a new locality. They were found in the Lower Fish Tooth Bed.

To the published description of *Hightea elliptica* Bowerbank (cf. REID & CHANDLER 1933: 439, pl. 24, figs. 1-17 where references to BOWERBANK are given) a few additional points can now be added from V.51657, the most perfect specimen seen in forty years experience. The epicarp is smooth and shining, the basal obconical structure ("calyx" of BOWERBANK but probably merely the receptacle or top of the stalk) is still attached. It has five well-marked angles which diverge from the centre. They are continued up the sides of the fruit as five longitudinal nerves, one of which is clearly shown in pl. 7, fig. 10. The stalk itself is slightly out of focus in the figure but its shape is clear as is the potential line of separation from the fruit. This should be compared with BOWERBANK 1840, pl. 8, figs. 10, 25, where separation has actually started. The appearance of fruits after separation has taken place is depicted by him in pl. 8, figs. 1, 3, 11, 13. This receptacle is rarely preserved but was seen in V.45218. The apex of V.51657 also has a clearly defined five-ribbed scar from which the central style projects prominently, the whole forming a low five-sided conical structure with radially puckered and fluted surface. It is delimited from the main body of the fruit by a horizontal ridge which may, or may not, have borne free sepals (no longer preserved if so). The apical styler scar must indicate either an inferior fruit with accrescent calyx or a fruit sunk in an enlarged torus so as to simulate an inferior fruit like that of *Anneslea* (Theaceae). BOWERBANK depicts specimens from which the styler scar has broken (pl. 8, figs. 11, 15, 17, 22, 23). Germination of the lower tier of seeds would have been facilitated by the detachment of the stalk and that of the upper tier by the shedding of the styler scar. REID & CHANDLER believed the apex of the fruit split into segments or valves when the upper tier of seeds was infertile. CHANDLER 1964: 121, placed *Hightea* provisionally only in the Theaceae. Length of V.51657 19 mm; transverse diameter at broadest point (about 12 mm from base) 11 mm. Diameter of styler scar 2.5 by 2 mm; length 1.5 mm. Diameter of basal stalk 3 mm; length (depth) 1.5 mm.

The systematic position of *Carpolithus pusillus* (REID & CHANDLER) with its three varieties described by CHANDLER (1961: 304, pl. 30, figs. 21-25, pl. 31, figs. 1-7; text-figs. 46-47) is still undiscovered. In the material earlier examined,



the boat-shaped carpel displayed a large, rough ventral scar representing the outer surface of a plug of parenchyma pierced by fibro-vascular strands. A small fruit (cf var. *latus*) V.51659 from the Beetle Bed, Bognor, is 3.5 mm. long, 2.8 mm. broad, thickness 2.5 mm; it has the typically rippled exocarp well preserved. An unbroken coat forms a smooth shining projection over the whole attachment region pierced only at its centre by the base of a small stalk. The smooth area is 1.5 mm. in diameter. It, at first sight, resembles an inverted cup-shaped calyx as in some palms (Pl. 7, fig. 14). Close examination shows it to be merely a loose fitting prominent part of the exocarp for it passes without a break into the rippled surface which covers most of the fruit. The smooth region is formed of quadrangular approximately equi-axial cells with rounded angles ranging in size from 0.028 to about 0.057 mm. in diameter. Similar cells are visible in the furrows between the ripples but are masked by puckering over the ripples themselves. They are again very obvious over the pointed tip (style) of the fruit which is devoid of ripples. They diminish in size towards the tip from which they diverge. A canal pierces the extreme tip. If, as appears likely, *C. pusillus* is a single-seeded fruit it must be borne in mind that the three varieties may conceivably be larger, coarser and smaller younger fruits which occupied a different position on an inflorescence. Such a theory cannot be confirmed without knowledge of the habit of growth. This can only be known when the true relationship of these fruits is discovered.

*Olex arnensis* (Chandler) described as *Carpolithus arnensis* from the Lower Bagshot of Arne (CHANDLER 1962: 148, pl. 24, figs. 10-13) and Bournemouth Marine Beds, Southbourne (CHANDLER 1963: 139, pl. 22, figs. 36, 37) is now placed in the family Olacaceae, genus *Olex*. Although the similarity of the external fibres to those of *Olex* was noticed and discussed, in recent specimens then examined the fibres were seen to occupy the inner part of the fruit wall. Now, however, in the genus *Olex* itself identical external fibres have been seen. The species most closely examined was somewhat smaller than the fossil (length 10 mm; diameter about 15 mm) and its broken apex had split and curled inwards as in the fossil. It also possessed a similar large internal chalaza scar. *Olex* is distributed through all typical lands of the Old World.

#### LOCALITY CORRECTIONS

A large fan-palm leaf, V. 10879, was reproduced by CHANDLER (1962: 161; text-fig. 25) from an unpublished lithograph by GARDNER in the British Museum. This specimen bore a label some thirty years old: Pipeclay, Alum Bay. The ascription is believed to be quite erroneous, the label being one of many which have caused confusion. Mrs. Jane CROUCHER while working on the as yet unstudied GARDNER leaf-impressions in the Museum made a close scrutiny of the matrices. She reports, on the strength of this, that V. 10879 is from the Dorset Pipe Clays of Lower Bagshot age, either from Corfe or from Furzeybrooke, Creech Barrow. The matrix is quite distinct from that of the Alum Bay Pipe Clays. Old published references to large fan palms refer them to these two Dorset localities. There is no mention of such palm leaves from Alum Bay. The Sedgwick Museum have three well-localized leaves from Corfe Castle and the Geological Survey has one labelled Corfe, one labelled Isle of Purbeck, and one from Furzeybrooke, Creech Barrow. Thus evidence from matrices and literature supports Mrs. CROUCHER's opinion as to the origin of V. 10879. The erroneous label is not an original collector's label and should now be disregarded.

An incomplete pinnate palm leaf represented by counterparts was described by CHANDLER (1964: 129, pl. 4, fig. 31) the smaller part only being figured. The larger counterpart is shown in Pl. 16, fig. 1 of this Monograph, and the smaller in Pl. 17, fig. 1. Owing to a misunderstanding of Mr. FORD's statement the locality given in 1964 was incorrect. The mistake was only realized when Dr. CHESTERS visited the site in his company and the position where it was collected was pointed out to her. The ironstone slab in which it was preserved was loose on the shore between two block houses to the east of Yarmouth (not between the two large forts to the west of the town). It most probably originated, therefore, in the Hamstead Beds not, as previously inferred, in the Headon or Osborne Beds. It is the only pinnate palm fragment yet collected in the Isle of Wight Tertiary Beds.

Mrs. CROUCHER has also pin-pointed the exact site in the cliffs west of Bournemouth pier which yielded the large pinnate palm-leaf, V. 16850 (figured CHANDLER 1963: 5, text-fig. 1 after an unpublished GARDNER figure). It and other palms were from Little Durley Chine. The fragment, V. 44296 (figured CHANDLER 1963: 7; text-fig. 3) which was preserved in a light coloured matrix like that which yielded *Gleichenia* was correctly stated to be from the cliffs below the Highcliff Mansions and Coastguard Station.

## SYSTEMATIC DESCRIPTIONS

## 1. THE LONDON CLAY

## ANGIOSPERMAE

## Class MONOCOTYLEDONES

## Family CYPERACEAE

Genus *POLYCARPELLA* Reid & Chandler 1933: 486

**Emended diagnosis.** Fruiting head a crowded capitulum hemispherical to ellipsoid. Fruits either solitary in the axis of a glume of the spikelet or more probably with an immature fruit also inside the glume. In either case the detachable unit is somewhat laterally flattened, elongate-obovate, surrounded by a few flat setae arising at the base, with fruit one-loculed, one-seeded. Pericarp thick at the apex, thin laterally, parenchymatous. Length of most perfect capitulum, 7 mm; transverse diameter in all directions, 10 mm. Length of second specimen, 11 mm; diameter, 10 by 15 mm. (all dimensions reduced by abrasion of fruit apices). Length of fruit preserved about 4 to 4.5 mm. (always incomplete apically); maximum diameter 2 to 2.5 mm; least diameter 0.75 to 1 mm. Seed erect, anatropous, subcylindric, hilum attached to a thick basal carbonaceous placental plug.

*Polycarpella caespitosa* Reid & Chandler

(Pl. 2, figs. 1-6; Text-fig. 1a, b)

1933. *Polycarpella caespitosa* Reid & Chandler: p. 486, pl. 27, figs. 13-21.1961. *Polycarpella caespitosa* Reid & Chandler: Chandler, p. 301, pl. 30, figs. 8, 9**Diagnosis.** That of the genus.**Holotype.** V.23097 now fragmented, Paratype V.51634.

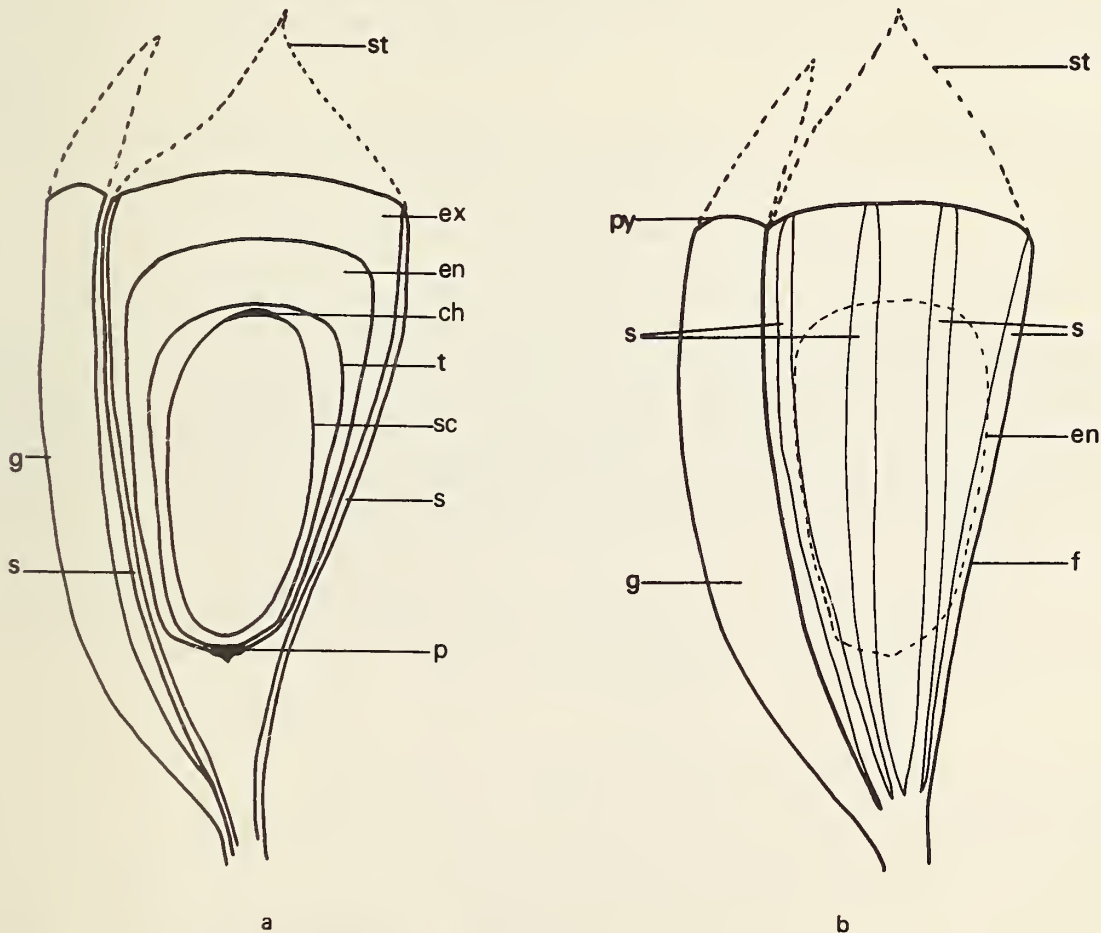
**Description.** Fruiting head: A crowded capitulum (usually imperfect), subhemispherical to ellipsoid, hollowed below owing to the recurved form of the lowest fruits and of a ring of bracts of which the bases only now remain (cf. reconstruction Pl. 2, fig. 5). Fruits and bracts arise from a subglobular stalked parenchymatous placenta, about 1.5 mm. long, 2.5 mm. in diameter. Shape and number of bracts unknown. Stalk in longitudinal section formed of a cylinder of longitudinally elongate and aligned angular cells surrounding a median core (pith?) several cells in diameter, of shorter broader cells. Small perfect capitulum 7 mm. high, 10 mm. in transverse diameter. Larger, incomplete (?) specimen 11 mm. high, 10 by 15 mm. in diameter; all dimensions somewhat reduced by abrasion of the fruit apices.

Fruit: The fruits appear to be borne in the axil of a glume on short spikelets. The glume probably enclosing a second immature fruit or a flower (evidence preserved inconclusive). Glume and fruit together somewhat laterally compressed, elongate obovate in outline. Probably originally pointed at the apex which is now truncated by abrasion of both fruit and glume, so that the distal end appears slightly but unequally bilobed. The larger lobe corresponds with the ripe fruit, the smaller with the glume, the furrow between the two being at right angles to the broader surfaces (Text-fig. 1b). The spikes are heavily pyritized, the pyrites filling all cell and other cavities. Base of spikelet attenuated, provided with a number of setae which extend to the apex as preserved but have lost their distal ends by abrasion. Setae flat, thin, longitudinally striate, narrowing gradually upwards, formed of longitudinally elongate and aligned cells, partly carbonaceous with pyrites filled cavities. A few marginal, multicellular, widely spaced, reflexed hairs are borne on the margins of the setae towards their upper ends. There were probably more such hairs, less sparsely scattered along the abraded tips. The hairs are seen to be formed by cells arranged in a line end to end. The pyritization makes it impossible to detect any smaller basal glumes if present at the base of the fruits.

Each fruit (cf. Text-fig. 1a) is one-loculed, one-seeded, with elongate locule in the lower half. The epicarp to which the setae are cemented by pyrites is formed of longitudinally aligned rectangular cells. The exocarp forms the attenuated base where it is fairly thick. In longitudinal section it shows elongate cells or fibres which divide and diverge upwards forming a cup-like structure which holds the endocarp. Higher up on the sides of the fruit the exocarp is thin and parenchymatous. At the apex, it again becomes very thick and spongy, but owing to abrasion its full extent is not preserved. Endocarp long and narrow, more or less obovate and somewhat flattened like the fruit. It is formed of spongy parenchyma coarser than that of the exocarp but is also very thin over the sides and thick at the apex. A circular thick



plug of tissue closes a small aperture at its base and bears a small central mucro below. The plug forms the placenta for the seed. Exocarp and endocarp are tightly cemented together by pyrites but a sharp line of demarcation between them can sometimes be distinguished especially where the tissues are thickest near the apex. Length of fruit (always incomplete) 4 to 4.5 mm; maximum diameter 2 to 2.5 mm; least diameter at right angles to this 0.75 to 1 mm.



Text-fig. 1. *Polycarpella caespitosa* Reid & Chandler.

a. Reconstruction of a longitudinal section of a fruitlet (or spike with two fruits) detached from capitulum.  $\times \pm 20$

- g — possible glume or immature second fruit.
  - st — style arising from attenuated tip of ripe fruit.
  - s — setae forming external cup.
  - ex — spongy exocarp, somewhat fibrous at base.
  - en — more coarsely spongy endocarp, thick above, thin on sides of fruit.
  - t — testa of seed.
  - sc — internal cast of seed.
  - ch — chalaza on sc.
  - p — carbonaceous plug forming placenta and hilum.
- Abraded parts shown by dotted lines.

b. Surface of another detached fruit (or spike) seen from side.  
st, s, g as in Fig. 1a.  $\times \pm 20$

- f — ripe fruit closely adherent (through pyritization) to a glume or immature fruit.
  - py — abraded pyritized upper end of fruit and glume (or immature fruit) showing asymmetrically placed groove between them (seen on most detached specimens) on the worn pyrites surface.
- Position of endocarp, en within is shown by dotted lines.  
Abraded apices of glume and fruit shown by dotted lines also.

**Seed:** (Text-fig. 1a) Subcylindrical or cigar-shaped, erect, anatropous, slightly truncated below by the circular hilar scar attached to the placental plug. Chalaza a large, circular scar with central point from which the cells diverge and around which they are concentrically aligned. It covers the rounded apex of the seed and is best exposed when the

testa and its internal pyrites cast are chipped away. The positions of hilum and chalaza at the opposite extremities of the seed indicate an anatropous structure as suspected by REID & CHANDLER. Direct evidence of the raphe seen and described by them was regarded as doubtful. Seed-cast elongate-fusiform, often preserved in glistening pyrites bearing the shallow convex impressions of quadrilateral or polygonal equiaxial cells, 0.028 mm. in diameter. The carbonaceous testa cells themselves are sometimes present on a thin film of pyrites; they are longitudinally aligned, oblong or fusiform. There are traces of transverse striation on fragments of the internal surface of the testa. Length of seed, 1.8 to 2 mm; diameter, 0.6 mm.

**Remarks.** In 1933 only the holotype, V.23097 was known. It, V.51133, and V.51634, are all from Sheppey. V.30483 (figured CHANDLER 1961: 301, pl. 30, figs. 8, 9) is from Herne Bay. Heavy pyritization formerly caused difficulty in the understanding of this plant. The problem is discussed in some detail in the Introduction on p. 4 where preservation in pyritized and carbonaceous material and the different kinds of evidence they provide are considered. The better understanding of this question together with re-examination of the holotype and new material has led to an interpretation differing in important respects from that of REID & CHANDLER (1933: 486). The seed was formerly thought to be anatropous and pendulous, the micropyle represented by the apical scar and the chalaza by the basal one. It is now clear that it is erect and anatropous with apical chalaza and basal hilum as described above. The old interpretation excluded relationship with Cyperaceae as was expressly stated but the new, on the contrary, indicates that this is the true affinity. Study of Recent Cyperaceae and of fossils from the Bournemouth and other Lower Tertiary floras confirms this view. It shows also that *Polycarpella* differs from the Caricoideae (*Cladium*, *Mapania* and the fossil *Caricoidea* Chandler) in the elongate narrow form of the endocarp and seed. A capitulum like the one described above is present in more than one genus of the family Cyperaceae. One of the most comparable is *Rhynchospora*. *R. elatior* Kunth has its large capitulum borne on a rigid stout stalk with a basal involucre of elongate bracts. In this, and in some other genera, the individual entities detached from the capitulum may be spikelets bearing several alternating fruits in the axis of glumes. *Rhynchospora* may have one or two fruits only to each spikelet. The arrangement and number of the fruits and of the glumes around each appears to be of importance in the determination of Cyperaceae genera. In view of some uncertainty about these points the name *Polycarpella* is retained but it is probable that the fossil is most closely allied to *Rhynchospora*, a world-wide genus in temperate and tropical regions.

### Family PALMAE

#### Section CORYPHEAE

#### Genus *CORYPHA* Linnaeus

#### *Corypha wilkinsoni* n. sp.

(Pl. 2, figs. 7, 8)

**Diagnosis.** Seed obovoid with obovoid hilar-chalaza scar. Embryo on opposite side about 2.5 mm. from base (hilum). Length of seed case, 10 mm; breadth, 8 mm; dorsiventral thickness, 7 mm.

**Holotype.** V.51635.

**Description.** **Seed:** Represented by the internal cast with remains only of integuments impressed on fragments of pyrites film. It is largely equivalent therefore to the albumen which is entire, not ruminant. Bisymmetric around a plane through hilum and chalaza, obovoid with deep ventral somewhat spatulate depression filled by the pyritized remains of a thickened raphe and chalaza arising from the basal hilum. Remains of carbonaceous testa persist in a shallow groove which outlines this hilar-chalazal scar. The groove is continued to the very base of the seed. Embryo scar on opposite side approximately in the plane of symmetry (pushed? by slight distortion of the specimen a little to one side and pressed down towards the hilum so as to lie at about 2.5 mm. from the base of the cast). The scar prominent, made conspicuous by furrows which diverge from it over the dorsal surface, conspicuous deep furrows also diverge from the hilar-chalazal scar over the central surface of the case. Some of these may be fibre impressions. Fragments of pyrites film on the surface of the seed cast show fine elongate cells producing striations beneath which are very small equiaxial cells. Length of seed cast 10 mm; breadth 8 mm; thickness in plane of symmetry 7 mm.

**Remarks.** One seed from Warden, Sheppey, named after the finder Dr. H.P. WILKINSON. It bears so close a resemblance to the Recent *Corypha olivaeformis*, a Malayan species, that it is barely distinguishable from it when the Recent seed has been divested, by maceration, of its testa. The chief differences are its slightly smaller size (possibly an



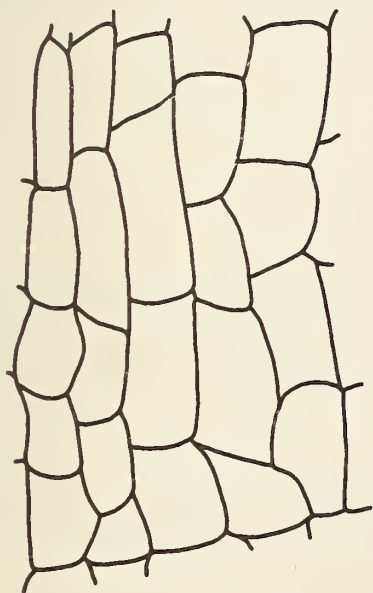
individual variation as one seed only has been found); length of the Recent seed 11.5 mm. by 9 mm. and the position of the embryo scar which is about 0.5 mm. more remote from the hilum in the living than in the fossil. In the living *Licuala* and *Livistona* the embryo scar is much further from the hilum on the dorsal surface. The form of the seed and spatulate hilar-chalazal scar also recall *Serenoa eocenica* Reid & Chandler (1933: 108, pl. 1, figs. 18, 19) a considerably smaller seed (7.5 by 6 by 6 mm.) further distinguished by the embryo scar closely adjacent to the hilum and by the narrower more attenuated hilar-chalaza scar. *Palmospermum minimum* Reid & Chandler (1933: 114, pl. 1, figs. 30, 31) is even smaller although of comparable type (length 6.6 mm; breadth 5 mm. ) again with a relatively broader, less gradually attenuated hilar-chalazal plug.

### Genus *TRACHYCARPUS* Wendl.

#### ? *Trachycarpus* sp.

(Pl. 2, figs. 9-11; text-fig. 2)

**Description.** **Fruit:** Broadly kidney-shaped, the slight concavity parallel with the axis; bisymmetric in a longitudinal plane through the centre of the concavity. Attachment circular, styler scar apical, small. The surface opposite the concavity rounded. Papery epicarp abraded but in one or two patches the angular equiaxial cells of its inner side are represented as impressions on a thin film of pyrites. Surface inside the epicarp much abraded but in places, on the rounded lobes which flank the attachment, there are remains of coarse irregular areoles which in Recent material are full of a shining secretion. These areoles are in groups, separated by smooth furrows, which on the shole are longitudinally aligned.



Text-fig. 2. ? *Trachycarpus* sp.

Secreting cells full of shining pyrites. They occur in flat, often sinous bands interspersed among longitudinal fibres of an inner coat of the pericarp.  $\times \pm 1000$

Where this secreting coat is missing in the ventral concavity, longitudinal fibres converge at the base and apex to the attachment and style. Interspersed among them are flat bands, several cells wide, of elongate cells which are irregular in length and breadth and flattened parallel with the surface (text-fig. 2). They also have the appearance of secreting tissue and are now filled with smooth shining pyrites. All the above can be seen in Recent *Trachycarpus*. The seed itself is hidden by the overlying tissues of the exocarp described above. Embryo scar not seen, but difficult to detect in the living seeds where it is situated at the centre of the rounded surface on the opposite side to the concavity. Length of seed along axis 10 mm; maximum transverse diameter at right angles to plane of symmetry 14 mm; maximum thickness in plane of symmetry through the concavity 10 mm.

**Remarks.** One seed V.51636 from the Beetle Bed, Bognor resembling *Trachycarpus* in the kidney-shape and succession of coats. The seed is more broadly kidney-shaped than *T. excelsa* and considerably larger, corresponding measurement for the Recent species being: 8 by 11 by 6.5 mm. Also in the Recent species the styler scar lies somewhat below the apex at the top of the concavity. In the absence of evidence as to the position of the embryo vesicle the reference to *Trachycarpus* is provisional. The genus ranges from Japan and China to the western Himalayas.

Genus *PALMOSPERMUM* Reid & Chandler 1933: 110*Palmospermum jenkinsi* Reid & Chandler

(Pl. 2, figs. 12, 13)

1933. *Palmospermum jenkinsi* Reid & Chandler: p. 110, pl. 1, figs. 23, 24.1961. ?*Palmospermum jenkinsi* Reid & Chandler: Chandler, p. 124, pl. 13, figs. 8, 9.

**Description.** Seed cast: V.51637 Bisymmetric, non-ruminate, subglobular but somewhat flattened on the ventral surface which is excavated by the large deep hilar-chalazal depression (Pl. 2, fig. 12). Depression narrow obovate in outline. The actual tissues of the hilar-chalazal scar are largely abraded. Embryo scar large, conspicuous, circular, convex, situated close to the plane of symmetry on the dorsal side of the cast close to the hilum but above the base. Surface of seed cast showing fine angular equiaxial cells. Furrows diverge from the chalaza; they sometimes branch and anastomose at acute angles and may represent fibres now worn away. Furrows also diverge from the centre of the embryo scar. Length of seed cast 9 mm; breadth 9 mm; dorsi-ventral thickness 7 mm.

**Remarks.** This cast from Warden Point, Sheppey, agrees with *Palmospermum jenkinsi* previously recorded from Herne Bay. It differs only in the slightly asymmetric position of the embryo scar in relation to the plane of symmetry, the scar being slightly larger and more conspicuous than in the type. There is also some resemblance to the smaller species *Palmospermum pulchrum* Chandler (1961: 127, pl. 13, figs. 25-31) of which the diameter in all directions is only 5.5 mm. In *Palmospermum* sp. 6 (REID & CHANDLER 1933: 116, pl. 1, figs. 35, 36), another similar but smaller species, the embryo scar is more strictly basal.

## Family NIPACEAE

Genus *NIPA* Thunberg*Nipa burtini* (Brongniart) Ettingshausen

(Pl. 18, figs. 3-5)

1933 *Nipa burtini* (Brongniart): Reid & Chandler p. 118, pl. 2, figs. 1-6.1960 *Nipa burtini* (Brongniart): Chandler p. 133, pl. 14, figs. 4-91961a *Nipa burtini* (Brongniart): Chandler p. 33, pl. 9, fig. 49; pl. 10, figs. 51-531963 *Nipa burtini* (Brongniart): Chandler p. 72, pl. 10, figs. 1-7

Three ironstone casts of typical *Nipa* fruits V.52789 require no detailed description, but come from a new locality at Cliff Reach, Burnham-on-Crouch, Essex. All are crushed and were probably immature or sterile as no trace of seed is preserved. The figures give the size.

## Family ARACEAE

## Section MONSTEROIDEAE Engler

Genus *EPIPREMNUM* Schott*Epipremnum* sp.

(Pl. 3, figs. 1-3)

**Description.** Seed: V.51638 Bisymmetric in plane of micropyle and hilum, probably orthotropous (although possibly half anatropous), sausage-shaped and curved. Testa much abraded where preserved. Entirely worn away over one lateral surface, over the chalaza and ventral margin. Almost entirely removed over the micropylar end of the seed so that the radicle is exposed. Remains of the testa show traces of superficial cells transverse to the axis of the seed and a tendency to transverse alignment of the underlying spongy tissues which are formed of small equiaxial cells about 0.027 mm. in diameter. Maximum thickness of spongy tissue preserved, 0.29 mm. On the more abraded side of the seed a film of



pyrites representing tegmen or a thin layer of albumen is visible over the internal cast. It is flattened in the plane of symmetry but is missing over the bluntly pointed cylindrical symmetrical radicle of which about 1 mm. is exposed (Pl. 3, fig. 2). This film shows the impression of thin-walled cells arranged in longitudinal rows about 0.069 mm. wide. The longitudinal walls are sunk giving a coarsely longitudinally striate surface possibly made more conspicuous by slight shrinkage or contraction prior to fossilization. The cells may be rectangular or four-sided with oblique end walls, hence some appear pointed. Others are oblong and at least 0.23 mm long. Fine transverse striae seen on these cells may represent the superposed cells of the seed cavity. The cells of the radicle are longitudinally aligned and at largest about 0.038 mm. in diameter, decreasing in size towards the tip where they converge to a small circular micropylar scar, 0.114 mm. in diameter. The external form and size of the micropyle are of course lost with the abrasion of the testa in this region. At the opposite end of the seed a circular chalaza scar about 0.7 mm. in diameter is seen on the inner angle of this limb of the curved seed cast. Maximum diameter of seed 3.5 mm. Length preserved, measured along the outer curve of the seed from tip to tip 7.75 mm. Diameter at right angles to the above 2.25 mm. Thickness of seed preserved (one side of testa missing) 1 mm.

**Remarks and affinities.** The form of the seed, position of organs and testa texture and structure indicate the family Araceae. The curved cavity with organs at and near the extremities point to the section Monsteroideae. The nearest approximation to this form among the living is found in *Epipremnum* but it must be borne in mind that examination of a number of related genera was impossible. Moreover the true external surface of the testa is not preserved in the fossil so that conspicuous external pits if present have been destroyed while the seed cavity has a more open less arcuate curve than in the limited number of *Epipremnum* species seen. In this respect and in size there is a resemblance to *E. ornatum* Reid & Chandler of the Bembridge Marls about which comparatively little is known. The fossil also shows a wider curve than in the genera *Spathiphyllum* and *Scindapsus*. In view of the imperfect character of the solitary seed it is referred to *Epipremnum* sp. without a specific name.

### Class DICOTYLEDONES

### Family JUGLANDACEAE

### Genus *PTEROCARYOPSIS* Chandler 1961: 142

A second species of this extinct genus has now been found in the Beetle Bed at Bognor. It appears to fall within the genus *Pterocaryopsis* as defined. It is quite different from *P. bognorensis* Chandler, the diagnosis of which was originally given as "That of the genus". It becomes necessary, therefore, to provide a more definite specific diagnosis showing briefly the characters by which it is distinguished from the new species *P. elliptica*.

### *Pterocaryopsis elliptica* n. sp.

(Pl. 3, figs. 4, 5)

**Diagnosis.** Fruit transversely elliptical in outline with slight mucro at apex and very small narrow excavation at the base adjoining the basiventral attachment. Attachment between the lobes of the endocarp which narrow downwards so as to embrace it. Endocarp occupying nearly half the breadth of the fruit and the lower two-thirds of its length.

**Holotype.** V.51639.

**Description.** Fruit: Bisymmetric, more or less flattened at right angles to the plane of symmetry, transversely elliptical in outline with a slight mucro at the styler end and a small narrow excavation at the base adjoining the basiventral attachment. Endocarp obscured to a considerable extent by the exocarp but situated medianly in the lower two-thirds of the fruit and somewhat flattened dorsiventrally. It is flanked laterally by two thick smoothly rounded wings which are also continued as a broad band around its upper end to the style. The endocarp is indicated by the two subparallel longitudinal projections of its primary lobes on the lower surface of the fruit. These lobes are broadest at their upper ends narrowing towards the base where they flank the attachment scar lying in a subtriangular hollow adjoining the lower margin. Around the endocarp, between its primary lobes and continued above it to the apex, is a conspicuous broad furrow which outlines its shape. There are traces of a median longitudinal fibre strand in this furrow. Beyond it the surface of the fruit on this side is slightly convex; the margin is rounded, not sharp, at least as preserved. On the upper surface of the fruit the endocarp is not apparent, so that it must have been almost flat. The

fruit itself is biconcave having a very shallow concavity on each side of the middle longitudinal line. The concavities are flanked by a rounded rim. A broad flat median fibre band arises at the basal excavation but is soon hidden under confused remains of organic tissue above. On both sides of the fruit there is a finely striate epicarp formed of narrow elongate cells about 0.01 mm. broad. On the whole these cells are aligned longitudinally, but they lie parallel with the margin near the edges of the wings, converge towards the stylar mucro at the apex, and diverge from the basiventral attachment so as to lie obliquely over the lobes of the endocarp. In places the longitudinal striations appear finely sinuous. In a few patches where the striate epicarp has gone, coarse, equiaxial angular parenchyma cells 0.018 to 0.027 mm. in diameter are exposed. They form the thickness of the opaque wing. There is no evidence of any stout superficial nerves diverging over the wings from the endocarp. Length of fruit 3.75 mm; breadth 5 mm; thickness 1 mm. Length of endocarp partly obscured by exocarp. Breadth across the endocarp 2.5 mm.

**Remarks.** One fruit from the Beetle Bed, Bognor, of the same winged type as *Pterocaryopsis*, resembling those species of *Pterocarya* in which the lateral wings lie one each side of the endocarp, not horizontally and at right angles to its length. The species differs in clearly defined respects from *Pterocaryopsis bognorensis*. Thus it had an elliptical winged fruit in contrast to the bilobed winged fruit of that species. It differs also in the wing which continues as a broad band around the upper end to the style. The prominent primary lobes on the lower surface and the narrowing of these lobes so as to embrace the basiventral attachment are distinctive features. Further, the endocarp is relatively larger in relation to the wings than in *P. bognorensis*; it occupies the lower two-thirds of the fruit, so far as its length can be seen, whereas in *P. bognorensis* it is situated at the middle. Its breadth is almost half that of the whole fruit (almost a third in *P. bognorensis*). There appear to be adequate grounds for separating the two as distinct species in spite of the temptation, at first sight, to regard them as fruits of a single species owing their variations to the relative positions in an inflorescence. When the two are examined side by side it becomes clear that this does not account for the differences observed.

#### Family MENISPERMACEAE

##### Section COCCULINAE

##### Genus *DAVISICARPUM* Chandler 1961: 157

##### *Davisicarpum gibbosum* Chandler

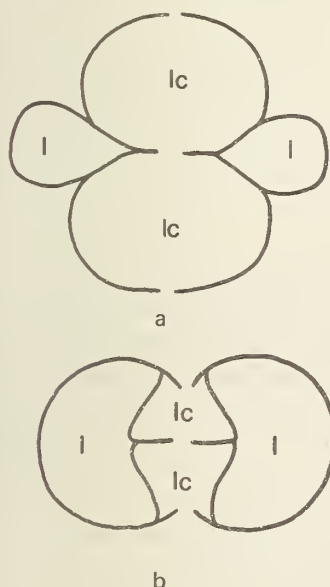
(Pl. 3, figs. 6-8; text-fig. 3)

1961 *Davisicarpum gibbosum* Chandler: p. 157, pl. 16, figs. 5-7.

In 1961 an endocarp of unusual form, believed from its curvature and marginal locule to be referable to Cocculinae was described under the name *Davisicarpum gibbosum*. It was then stated that "no living genus has been seen with a comparable gibbous central area giving an obliquely gibbous ventral margin". A second endocarp, with carbonaceous wall preserved, found by Dr. H.P. WILKINSON at Warden, makes it necessary to modify the original description slightly and shows the nearer affinities of the fossil. In this specimen, V.51128, a median gibbous area between the limbs is a conspicuous feature but is much less markedly oblique than in the Holotype, V.29837. It is so inflated as to cause the endocarp to be subglobular. Reference to allied living material suggests that this may be a more normal form so had it been found first it would have provided a more satisfactory Holotype. Both broad surfaces are much more inflated than in the Holotype and the two sides are symmetric. The inflated region is embraced for rather more than half its circumference by the broad shallow marginal locule which tapers conspicuously at the radicular end but is somewhat truncate at the opposite end thereby demonstrating that in the Holotype this end was in fact complete, a matter originally in doubt. The narrow rim at each side of the gibbous ventral margin is less conspicuous in V.51128 although it is complete. On the radicular limb abrasion has exposed the micropylar end of the seed with testa formed of equiaxial cells. A deep central depression on one convex surface represents the gap due to incomplete fusion of the two curved limbs of the endocarp. The new specimen has a breadth of 7.1 mm; dorsiventral diameter 6.5 mm; thickness 4.75 mm; thickness of locular rim 2.8 mm. These endocarps differ clearly from *Menispermum*, *Sinomenium*, *Palaeosinomenium* and *Cocculus* in having a semicircular or marked convex outgrowth from the curved locular area which forms a dome over the normal concave region between the limbs and conceals it completely. The inner edges of the outgrowth almost meet over the middle of the hidden concavity leaving only a small aperture which shows in the fossil as a curved groove described in the Holotype. It is seen somewhat more obscurely in V.51128. A hollow compartment thus produced on the two broad surfaces of the endocarp is filled with pyrites in both specimens the pyrites cast being partially exposed by some abrasion of the thin outer carbonaceous wall. *Limacia* Lour shows the greatest resemblance to the fossil of all



genera that could be examined. It has a similarly inflated median area partly surrounded by a flattened ribbon-like locular rim. In *Limacia oblonga* (Wall) Miers the locular rim is continued further towards the attachment than in *Daviscarpum* so as to leave a small gap only between the ends of the limbs, whereas in *Daviscarpum* the gap is much wider. In *Limacia* there is a similar median aperture continued as a curved comma-shaped furrow to the attachment (cf. CHANDLER, 1961, pl. 16, fig. 5). In the related *Hypserpa* and *Eohypserpa* the lateral hollow compartments are much smaller and are bounded largely by the broad locule itself and only in a limited degree, especially in *Eohypserpa*, by an outgrowth or extension of its lateral walls. Consequently the form of the casts of these compartments is entirely different in the two cases (cf. Text-fig. 3). Their difference is again shown by comparing Pl. 3, fig. 9, a well-preserved



Text-fig. 3. Diagram showing general arrangement of endocarp as seen in transverse section in

a. *Limacia* and *Daviscarpum*

b. *Hypserpa* and *Eohypserpa*

l — locule; lc — lateral cavities covered by outgrowths from the locule wall in a, but largely by locule itself with a small outgrowth only in b. (Cavities are infilled with pyrites casts in fossil material)

The section is sited so as to cut across the 2 limbs of the curved locule.

carbonaceous endocarp of *Eohypserpa parsonsi* (V.51151) with Pl. 3, fig. 6 of *Daviscarpum*. In the former the broad locular area occupies approximately half the diameter of the endocarp. The limited convex extension of the locule wall and the central gap leading into the hollow compartment account for the other half diameter. In *Daviscarpum* the convex extension of the locule wall which covers in the lateral concavities accounts for the greater part of the diameter. In spite of its resemblance to *Limacia* the genus *Daviscarpum* is distinguished by the shortness of the locule limbs between which the broad convexity of the lateral compartments projects for about a third of the total circumference of the endocarp at the attachment end. *Limacia* has about five species in East Asia from Cochinchina through north west and south west Malaya to the Philippines.

### Section FIBRAUREAE

#### Genus *ATRIAECARPUM* nov.

**Introductory note.** In 1961 CHANDLER (p. 151, pl. 15, figs. 22-28, text-fig. 18) described an abundant endocarp from Bognor under the name *Menispermicarpum venablesi* n. sp. The use of the form-genus was necessary because no comparable living endocarps could be found. The most peculiar feature of the species was a pair of hollow ridges borne on the slightly concave ventral surface, one each side of the median longitudinal line, each directed towards the sides of the endocarp. Such could be produced in the living genus *Somphoxylon* if its ridges were enlarged considerably while the growth of their internal tissues failed to keep pace so that internal cavities were left. The shallow boat-shaped form of the endocarp wall around the locule suggested affinity either with Fibraureae or Tinosporeae. Now, however, it appears that the absence of a deep ventral condyle formed by a sharply curved locule indicates Fibraureae rather than Tinosporeae. The ridges are evidently outgrowths of the ventral wall of the endocarp. Their cavities are completely separated by locule wall from the true locule. Recent discoveries at Sheppey of a similar but much larger species with longer somewhat reflexed lateral ridges indicates the need for removal of *M. venablesi* from the form-genus *Menispermicarpum* and the institution of a new generic name for the two species. The name *Atriaecarpum* will therefore be used to denote them until such time as similar fruits are discovered on a living plant. The possibility of such a discovery must be borne in mind having regard to the fact that a considerable number of Recent Menispermaceae exist

of which the fruits are still quite unknown. Yet undoubtedly extinct genera exist in the Eocene and *Atriaecarpum* may well be one of these.

The diagnosis of the former *Menispermicarpum venablesi* has been emended to eliminate characters proper to the genus as opposed to the species. Its description has been enlarged to include a well-preserved seed from the Lower Aldwick Beds.

**Diagnosis of genus.** Endocarp bisymmetric, almost straight being slightly concave only on the ventral surface with corresponding slight degree of convexity on the dorsal side. A deep ventral hollow is therefore lacking. Both surfaces with median longitudinal suture ridge. Carpel wall having two superficial hollow outgrowths (*atria*) forming ridges one each side of the median line on the ventral surface. These open to the exterior by narrow slits at their lateral extremities.

**Type species.** *Atriaecarpum venablesi* (Chandler).

### *Atriaecarpum venablesi* (Chandler)

(Pl. 4, figs. 4, 5; text-fig. 4)

1961. *Menispermicarpum venablesi* Chandler: p. 151, pl. 15, figs. 22-28; text-fig. 18.

**Emended diagnosis.** Endocarp oval or suboval in outline. Shallow from back to front. Superficial hollow projections extend laterally only slightly beyond the outline of the wall bounding the locule, more or less symmetric above and below. Dorsal surface with two or three irregular rows of conical tubercles on each side of the median ridge. Locule wall with corresponding rows of low rounded prominences (shallow depressions on locule cast and seed). Length of endocarp 4.5 to 7.5 mm; breadth 4.25 to 5.5 mm; thickness 2 to 3.5 mm.

**Holotype.** V.30575.

**Description.** As published in 1961. The following additional data are now recorded. The longitudinal hollow ridges which flank the median ridge on the ventral surface are inclined at a low angle to that surface. They scarcely project laterally beyond it and sometimes do not extend to the limits of the locule wall. The upper surface of these hollow projections arises close to and parallel with the median ridge. The lower surface arises near the margin of the ventral surface so that the projections lie inclined at a low angle to the ventral surface. Abrasion sometimes reduces the external tubercles of the dorsal surface to irregular rugosities. Dimensions as given in diagnosis.

**Seed:** Similar to endocarp in shape but more narrowly ovate in outline and more conspicuously pointed above reproducing the form of the true locule without the superficial excrescences (ridges and tubercles) of the endocarp. Dorsal surface almost flat transversely, gently convex longitudinally with low median longitudinal rounded ridge flanked by longitudinal rows of shallow rounded depressions. About nine such occur in the rows adjacent to the ridge, fewer nearer the margins. Margin rounded. Ventral surface slightly concave only with a conspicuous rounded median longitudinal ridge terminating rather abruptly at about 1 mm. from the apex of the cast and 1.5 mm. from the base. Over the median ridge worn remains of carpel wall still adhere. Just below its upper end a small circular scar indicates the point of entry of the funicle to the placenta and to the hilum of the seed. The ridge with its film of endocarp overlies and obscures the thickened raphe-chalazal region of the seed. Over most of the ventral surface of the seed the testa itself is preserved but in places only as pyrite casts of its flattened cells. Testa cells largely equiaxial, angular, but they become elongate and



Text-fig. 4. *Atriaecarpum venablesi* n.sp.

Testa cells showing distribution of thickening in cell walls.  $\times \approx 2500$

radially arranged around the margin. When equiaxial they are often about 0.038 to 0.057 mm. in diameter. The elongate cells may be as much as 0.114 mm. long. Radial walls of testa cells thin but with scattered thicker black patches which



have the appearance of beads threaded at wide intervals on a string. (Text-fig. 4). This appearance is due to uneven somewhat irregular thickening of the walls. A similar structure is visible on the outer surface of the testa in certain Recent genera, e.g. *Pachygone*. Some of the "beads" are on the sides of the cells, some at the angles between them. Much of the dorsal surface of the seed is still obscured by a thin film of endocarp. Length of only seed-cast 4.75 mm; breadth 2.8 mm; maximum thickness 1 mm.

*Atriaecarpum deltiiforme* n.sp.

(Pl. 4, figs. 6-10)

**Diagnosis.** Endocarp quadrangular or delta-shaped in outline, shallow from back to front. Lateral angles formed by the prolongation of the hollow ventral ridges which are directed away from the stylar end of the endocarp and narrowed to the slit at their lateral extremities. Whole dorsal surface and lower part of ventral ornamented with coarse irregular rugosities having a tendency to diverge from the median ridge. Length of endocarp, 10.5 to 12.5 mm. Estimated breadth of smaller, more perfect specimen, 12 mm.

**Holotype.** V.51642.

**Description.** Endocarp: Quadrangular or delta-shaped in outline when perfect, shallow from back to front. Lateral angles of quadrangle formed by the elongation of the hollow ventral ridges which extend laterally far beyond the wall of the true locule. They are inclined at a low angle to the ventral surface of the endocarp and are directed away from the stylar end in such a manner that their axes form reflexed angles of about  $113^{\circ}$  above with the median ridge of the endocarp ( $67^{\circ}$  below). The ridges narrow to their outer extremities so that the slit-like aperture in which they terminate is short (only about 3 mm. long) i.e. relatively shorter in relation to the length of the endocarp than in *Atriaecarpum venablesi* (CHANDLER 1961, pl. 15, figs. 23, 26, 27). Inner surface of hollows within the ridges striate parallel with the direction of elongation owing to the fibres or elongate cells of which the ridges are formed at least internally. Upper wall of ridges thin, arising close to the median ventral line of the endocarp. Lower wall arising almost at the margin of the true locular area. Placenta subapical on the median ridge although much abraded, apparently situated at the level where the upper ends of the ventral ridges arise. Endocarp wall overlying the locule ornamented by coarse rugosities on the lower surface and at the lower end of the upper surface. At the lower end of both surfaces the rugosities give rise to irregular rounded tubercles showing a tendency to diverge from the median line of the endocarp. Locule and seed not seen. Length of larger specimen 12.5 mm; breadth (as preserved) 12.5 mm; thickness 7 mm; breadth of area surrounding the true locule 8 mm. Length of smaller specimen 10.5 mm; breadth of median line to edge of lateral projection 6 mm. hence estimated complete breadth 12 mm; thickness 5 mm; breadth of area surrounding true locule 7 mm.

**Remarks.** Two specimens from Sheppey, neither quite complete but complementary in the information provided. The Holotype (V.51642) shows the endocarp proper with its wall and one ventral ridge with abraded wall revealing the pyrites cast of its internal cavity surrounded by a thin film of fibrous tissue. The slit opening to the exterior at the lateral extremity is clearly seen. The corresponding ridge of the other side was only incompletely pyritized so was worn away and is now represented by a partly hollowed but rounded concretion of adherent amorphous pyrites. The larger specimen (V.51643) shows the true rugose endocarp. The walls of the ventral ridges have collapsed and the bases of their two hollows have been filled with pyrites accretions now worn and rounded giving a superficial resemblance to *Frintonia* (CHANDLER 1961: 155, pl. 16, figs. 1-4; text-fig. 19). In this specimen fibrous structure is present only on the dorsal side of one ridge near its junction with the true locule wall. *Frintonia* is quite distinct from *Atriaecarpum* despite its superficial likeness for its pyrites accretions lay in a deep ventral hollow of the true endocarp wall on each side of its central partition. The structure of *Frintonia* is therefore typical of Tinosporeae in which section it was placed. There was no evidence whatsoever of ventral superficial hollow outgrowths of the endocarp as in *Atriaecarpum*. The hollows in the endocarp of *Chandlera* Scott (1954: 77, pl. 15, figs. 32-41) from the Eocene Clarno Formation of Oregon are entirely different in character from the hollow ridges described above. In *Atriaecarpum* they appear within outgrowths of the endocarp wall. In *Chandlera* they lie within the normal thickness of the carpel wall around the locule. The American genus shows unmistakably the characters of Tinosporeae.

## Family ANONACEAE

Genus *UVARIA* Linnaeus*Uvaria ovale* (Reid & Chandler)

(Pl. 5, figs. 1-4)

1933. *Anonaspermum ovale* Reid & Chandler: p. 190, pl. 5, figs. 31-33.1961. *Anonaspermum ovale* Reid & Chandler: Chandler, p. 170, pl. 17, fig. 28.

**Description.** Pod: V.51645. Bisymmetric, subcylindrical but slightly flattened in a plane at right angles to the plane of symmetry, truncate at both ends as preserved; external surface of pod abraded. Probably slightly constricted horizontally between the seeds. Seeds in two alternating rows, attached to a line of parietal placentas on one side of the pod in the plane of symmetry so as to lie transverse to the length of the pod. Thus the broader surface of the pod shows two rows of seeds (Pl. 5, figs. 1, 2) the narrower at right angles to it one only (Pl. 5, fig. 3). It seems probable that the pod dehiscent in the manner of a follicle along the line of placentation. The apical end of the pod is occupied by a single seed overlapping the two seeds of the pair immediately below. Interspaces between the seeds appear to be occupied by parenchymatous (?pulpy) dissepiments. Seventeen seeds are preserved. The slight convexity of the exposed surfaces of the top and bottom seeds indicate that the pod is virtually complete, for elsewhere the contiguous surfaces of seeds are somewhat flattened. Length of pod (as worn), 30 mm. Transverse diameter, 13 mm. at right angles to plane of symmetry; 10 mm. in this plane.

Seed: Bisymmetric, oval in outline, markedly flattened but exposed broad surfaces in end seeds shallow convex; albuminous without concavity at the centre of the albumen so that the albumen was bipartite in transverse section. Without marginal groove, raphe marginal and inconspicuous, albumen deeply ruminate, ruminations coarse and contorted so that they tend to form a median ridge from which other ridges diverge. The branching and anastomosing of the ridges in places produce some coarse pits on the broad surfaces. The divergent radial ruminations often fork towards the margin. Remains of testa are represented by patches of tortuous fibres. Length of apical seed 7.5 mm; breadth 6 mm; thickness near margin where it could be measured 2.5 mm. Length of two basal seeds, 10 mm; breadth 7 and 5 mm. respectively; thickness about 2 mm.

**Remarks.** Although probably constricted between the seeds, the abraded condition of the specimen makes it uncertain what degree of constriction was visible on the outside of the pod. The measurements given for the seeds are underestimated as it is only the exposed albumen casts which are available as was the case in specimens originally described. In the present instance the albumen casts are hollow films of pyrites. In places, therefore, where abrasion has worn away the smooth surface of the albumen ridges they show as double lines which complicate the pattern of the albumen and make close scrutiny necessary for the recognition of its basic features.

The details now available about the pod exclude relationship with numerous one, two or very few seeded genera, also with any in which the carpels are united to form a one-celled ovary with numerous parietal placentas, e.g. *Monodora* and *Isoloma*. Pods in which a single row of seeds gives a "beaded" appearance to the fruit as in *Desmos* and *Dasymaschalon* also appear to be excluded. The bipartite character of the ruminations in transverse section as opposed to a quadripartite arrangement serves to eliminate relationship with many other genera like *Anona*. The evidence taken as a whole suggests that *Anonaspermum ovale* belongs to the genus *Uvaria* which may have similar pods with two tiers of numerous parietally attached seeds. Its seeds show a bipartite arrangement of albumen, no marginal groove, rather broad rumination ribs forking frequently towards the margin and often interrupted at the centre although sometimes crossing the seed without interruption. The ruminations sometimes form a longitudinal median sinuous rib. *Uvaria* is distributed through the warmer regions of the Old World mostly in Malayan mountains, Further India, tropical east Asia, west Africa and tropical Australia.

## Family CAPPARIDACEAE

## Genus ?

(Pl. 5, figs. 5, 6)

**Description.** Seed: V.51646. Rounded quadrangular, more or less bisymmetric, flattened, curved in plane of symmetry.



Limbs closely adpressed, separated by a thin film of testa. Micropylar limb narrower than the other. Furrow between the ends of the limb slightly curved. Testa largely abraded, surface faintly rugose as preserved. Seed cast showing elongate narrow cells parallel with the curvature. An adherent film of pyrites over the outer edge of the chalazal broader limb shows the impressions of digitate cells or more probably areoles, themselves built up of small equiaxial cells about 0.009 mm. in diameter. The digitate areoles are elongate along the margin of the limb where they measure about 0.05 by 0.027 mm. Elsewhere they are equiaxial, 0.05 mm. in diameter. The remains of testa between the limbs are formed of fine parenchyma. Diameter of seed in both directions 1.7 mm; thickness 0.75 mm.

**Remarks.** The worn condition of this seed cast with remains only of its integument makes closer determination impossible, but the form of the cast suggests that it belongs to Cappariaceae. One specimen only from the Beetle Bed, Bognor.

### Family ? (Burseraceae ?)

#### Genus ?

(Pl. 5, figs. 7-9)

**Description.** Endocarp: V.51647. Approximately bisymmetric apart from distortion. Long-oval in outline at right-angles to the plane of symmetry but with irregular margin. Profile as seen from the side hemispherical. Dorsal surface convex both longitudinally and transversely. On this side a thick median longitudinal rounded ridge lies between the centre and the lower broader end; a narrower median interrupted ridge lies in a shallow groove between the centre and the narrower end. Ornamentation of inflated cells radially aligned near the margins. Ventral surface slightly biconcave longitudinally with a large transverse opening just above the middle enclosing a transverse band of fibres. It resembles the placental aperture of Burseraceae but differs in being concave downwards not upwards as in that family. From a short distance above and below the aperture five equally spaced ridges diverge to the broader end and two to the narrower end which appears to have been slightly distorted so that it is not perfectly symmetrical (Pl. 5, fig. 7). When the endocarp is examined from the ventral side the two upper ridges show a shallow concave curvature downwards and enclose between them a Y-shaped area. Fine striae diverge from the aperture and this surface of the endocarp shows remains of a thin carbonaceous coat finely striate longitudinally. Length of endocarp 6 mm; breadth at placenta 3 mm; maximum breadth below placenta 3.5 mm; thickness (about the middle) 2.5 mm.

**Remarks.** One endocarp from Warden, Sheppey. The systematic position is doubtful. In spite of a certain resemblance to Burseraceae the form of the placental aperture differs as described above. Furthermore, no Burseraceae seen show the ornate surface with divergent ridges.

### Family SAPINDACEAE

Genus *SAPINDOSPERMUM* Reid & Chandler 1933: 370

*Sapindospermum taylori* n.sp.

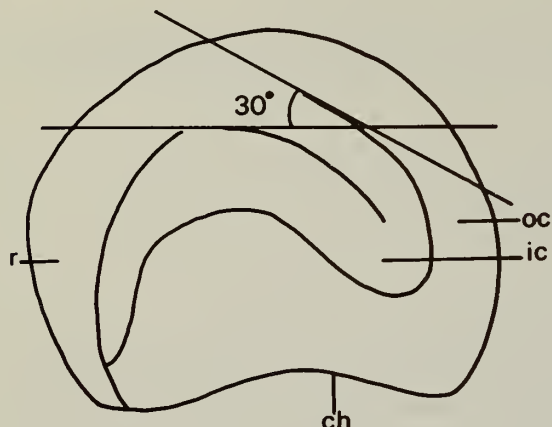
(Pl. 5, figs. 11-13, text-fig. 5)

**Diagnosis.** Seed small laterally compressed. Subgibbous in outline at right-angles to the plane of symmetry with long radicle embracing two-thirds of the gibbous margin. Cotyledons folded together, the first transverse fold of both rotated from the hypocotyl at an angle of about 30°. Inner cotyledon again folded to give a superficial lateral S or reversed S. Outer cotyledon probably with no second transverse fold, its thickened end fitting into the lower curve of the inner cotyledon. Length and breadth of broad surfaces, 3 by 2.75 to 3 mm; thickness at right angles to the above 2 mm.

**Syntypes.** V.51649 (Upper Fish Tooth Bed, Bognor), V.51686 (Beetle Bed, Bognor).

**Description.** Seed: Represented by internal casts with remains only of inner layers of the testa. Laterally compressed, broad surfaces gibbous in outline, the radicle forming the gibbosity, the opposite margin being straight or slightly concave. The radicle originally enclosed in a pocket of the testa extends from a third of the length from the upper end to the lower corner of the straight or concave margin, hence it embraces about two-thirds of the gibbous margin. It shows fine longitudinally aligned cells. Chalaza on the straighter margin at about the middle indicated by a transverse strap-shaped scar which reaches nearly half way across the lateral broad surfaces of the seed. Cotyledons folded together, the

first transverse fold of both rotated from the hypocotyl through an angle of about  $30^\circ$ . Cells preserved coarser than those of the radicle, following the curvature of the surface. A second reversed fold of the inner (lower) cotyledon gives it an S or reverse S-shaped outline on the flat surfaces of the seed, the tip of the lower fold ending against the chalaza. Outer cotyledon following the curvature of the inner but, so far as can be seen, it has no second transverse fold but its thickened end fits into the lower loop of the S described above. Length of V.51649 3.5 mm; breadth across the broad surface 2.75 mm; thickness 2 mm. Length of V.51686 3.5 mm; breadth 3 mm; thickness 2 mm.



Text-fig. 5. *Sapindospermum taylori* n.sp.

Side view of seed based on V.51686, to show folding of cotyledons.

oc — outer cotyledon; ic — inner; r — radicle; ch — approximate position of chalaza band.

The angle of rotation of the proximal fold of the inner cotyledon from the hypocotyl is indicated.

$\times \approx 2$

**Remarks.** Neither seed shows the external form or position of the hilum but films of pyrites reproduce different layers of the testa represented by small patches only. The films tend to obscure parts of the seed cast. Thus in V.51649 only the origin of the cotyledons is clearly visible but the strap-shaped chalaza is well seen on a pyrites film from which the surrounding cells diverge. On V.51686 the cotyledons are better displayed (Text-fig. 5) but the chalaza is not, the film of pyrites which reproduces it having gone. When first examined the radicle of this cast was perfect but with a small transverse crack. It is now detached. The seed is appreciably smaller than any fossil species earlier described. The mutual relationship of the two cotyledons is comparable with that of the Recent *Cardiospermum* (REID & CHANDLER 1933, text-fig. 9b) where the outer cotyledon has no second (reversed) transverse fold, but its end merely fits into the second loop of the S-shaped inner cotyledon. *Cardiospermum* differs, nevertheless, in its very short radicle and its larger sub-globose seed. *Sergania*, *Thouinia* and *Guoia pubescens* also have similar folding but a shorter radicle. The species appears recognizable enough to merit a name and has been called *Sapindospermum taylori* after the finder, the late Mr. H. E. TAYLOR.

### Family VITACEAE

Some species hitherto represented by one or a few seeds only are here figured, described or mentioned in order that a better basis for their diagnosis may readily be available and that the constancy of their distinctive characters may be demonstrated. A number of specimens are also included because they come from new localities or horizons. They are not necessarily figured or described in detail.

Among these are *Vitis bilobata* Chandler (1961: 246, pl. 24, figs. 22-24) from the Upper Fish Tooth Bed, Bognor (V.51088; Pl. 6, figs. 3, 4) with most of the thick testa preserved. The extreme base of this seed is broken showing bilobing of the base of the cast, its apex is slightly more channelled than in the Holotype from Warden Point, Sheppey, while its ventral infolds are a little longer and more divergent giving a raphe ridge which broadens upwards. The infolds occupy almost four-fifths of the length. The chalaza is seen to merge gradually into the raphe. The bilobed appearance of the dorsal surface is a characteristic feature. Length preserved 5.2 mm. (estimated original length about 5.75 mm); breadth 4.1 mm; thickness 4 mm. V.51089 is another typical seed from Sheppey; V.51090 a small seed from the Beetle Bed, Bognor; V.51091 a doubtful much encrusted specimen from the Upper Fish Tooth Bed, Bognor.

*Vitis obovoidea* Chandler (1961: 247, pl. 24, figs. 25, 28) is represented by V.51094-97, thirty seeds from the Beetle Bed and Lower and Upper Fish Tooth Beds, Bognor.

*Vitis magnisperma* Chandler (1961: 247, pl. 24, figs. 29, 30) comes from a new locality; the Upper Fish Tooth Bed, Bognor. A fine seed (V.51080) as good as the Sheppey Holotype but as it has more testa preserved on the dorsal surface its chalaza retains its original ovate form. Its ventral infolds extend throughout the lower four-fifths of the seed and both diverge upwards to the same extent as the right infold of the Holotype. The photograph shows the testa before it



had started to flake away (Pl. 6, figs. 5, 6). Length of seed 8.5 mm; breadth 6.5 mm; thickness 2.5 mm. A second doubtful specimen is V.51113 and V.51081 is a broken one. Both came from the same locality and horizon.

Other *Vitis* species are *Vitis bracknellensis* (V.51084-85) Warden and Bognor; *V. longisulcata* (V.51106-09) Warden; Beetle Bed, Bognor and Herne Bay (the last a new locality); *V. obovoidea* (V.51094-97) Beetle Bed, Lower and Upper Fish Tooth Beds, Bognor; *V. subglobosa* (V.51100-01, the latter now fragmented) Warden and Beetle Bed, Bognor. Two seeds of *Palaeovitis paradoxa* Reid & Chandler: V.51082 a fine specimen from Warden, V.51083 a smaller seed from the Upper Fish Tooth Bed, Bognor.

Descriptions are given of the more important specimens:

### Genus *VITIS* (Tourn.) L.

#### *Vitis* sp. (?*Vitis arnensis* Chandler)

(Pl. 6, figs. 1, 2)

1962. *Vitis arnensis* Chandler: p. 107, pl. 15, figs. 20-26.

**Description.** Seed: Narrowly-obovate in outline, rounded but somewhat channeled at the apex, attenuated to a point at the base but not stipitate. Ventral face smoothly rounded or slightly convex both longitudinally and transversely (sometimes faceted but flattened); raphe ridge rounded extending almost to the apex; ventral infolds almost straight but diverging slightly upwards, occupying the lower three-quarters at least of the length of the seed (sometimes as much as seven-eighths). In a flattened faceted specimen more markedly divergent upwards and extending the whole length, very conspicuous on the cast. Dorsal face very slightly convex so as to be almost flat. Dorsal and ventral faces meeting at a marked angle at the lower end of the seed in the best preserved specimen but the angle dies out above. Internal cast with fine radial fluting around the chalaza and with less conspicuous fine fluting around the ventral infolds. Chalaza elongate-ovate, about 3 mm. long and 2 mm. broad, situated at the middle of the dorsal surface, occupying almost half its length. Testa preserved in places over the chalaza and on the right side of the dorsal face, on the left side of the ventral face and at the base. It now appears rather thin and much polished by abrasion but may once have been somewhat rough. Dimensions of an undistorted seed (V.51111): length 8 mm; breadth 4.5 mm; thickness 3 mm; of a distorted seed with a point at the apex which is a secondary result of distortion 6.5 mm; breadth 4 mm; thickness 2.5 mm. The facets in this specimen are very unequally developed.

**Remarks.** Two seeds from Warden Point, Sheppey. There is a considerable resemblance to *Vitis arnensis* from the Lower Bagshot, the only differences in the better specimen being that the faceting on the ventral surface does not extend throughout the length; the infolds may be very slightly longer, the dorsal and ventral surfaces are sharply delimited by an angle only in the lower half of the seed. The slightly larger size may be due to pyritization. The reference to *Vitis arnensis* is treated as provisional pending the finding of more material in the London Clay.

#### *Vitis* sp. (?*Vitis excavata* Chandler)

(Pl. 6, figs. 7, 8)

1962. *Vitis excavata* Chandler: p. 108, pl. 15, figs. 29, 30.

**Description.** Seed: Transversely suboval, broadest above the middle, the two margins meeting at a wide angle at the base; not stipitate; apex rounded. Ventral face with a prominent narrow more or less parallel-sided raphe ridge merging above and below into the narrow margin of the seed. Between the marginal ridges and the raphe ridge lie two conspicuous areas. One is now preserved as a deep concavity, rounded in outline: the other as a pyrites cast of a similar concavity, its convex surface originally covered by a thin coat of black testa rapidly flaking away (Pl. 6, fig. 8). These structures indicate that the raphe ridge was flanked by two broad deep concave areas as in *Vitis excavata*, the areas being covered originally by the thin inflated testa which must have concealed their true nature in the undissected living seed. On the pyrites cast now exposed fine oblique striae are visible. The testa is close textured but its cell structure is obscure. Dorsal face gently convex; chalaza elongate-oblong extending to the base of the seed, contracted rather abruptly into the raphe at about three-quarters of the length of the seed from its apex. Raphe flanked by a pair of shallow apical depressions, chalaza by two rounded lobes corresponding in position with the ventral concavities described. Surface of lobes transversely striate. Length of seed 5 mm; breadth 5 mm; thickness 3 mm.



**Remarks.** One seed (V.51112) from Warden Point, Sheppey resembles in general plan *Vitis excavata* from the Lower Bagshot Beds, a slightly smaller (carbonaceous) seed, crushed and therefore less inflated. The chief difference lies in the elongate chalaza occupying the lower three-quarters of the seed and reaching the base. The Bagshot specimen has lost the testa which appears to have overlain the ventral excavations in the London Clay seed. It also has a shorter elongate-oval chalaza in the upper half of the seed. The similarity of the ventral surface suggests that if not the same species both seeds belong to a distinct section of the family Vitaceae. No Recent vine yet seen shows the peculiar features described.

### *Vitis rectisulcata* Chandler

(Pl. 6, figs. 9, 10)

1961. *Vitis rectisulcata* Chandler: p. 252, pl. 25, figs. 16-21.

1964. *Vitis* sp. (?*Vitis rectisulcata* Chandler) p. 102, pl. 2, figs. 7, 8.

A more perfect seed of this species has been found in the shell band at the base of the Oldhaven Series, Upnor, Kent (V.51132). It closely resembles the slightly imperfect seed already figured from this locality and horizon in CHANDLER 1964, pl. 2, figs. 7, 8. The seed is tilted in the figure so that the chalaza has a false appearance of being situated closer to the hilum than in the previously described specimen (V.45235). Length of seed 2.75 mm; breadth 2.5 mm; thickness 11.75 mm. There seems no reason any longer to query the reference to *Vitis rectisulcata* although the Upnor specimens are very slightly smaller than those from the London Clay.

### *Vitis* sp.

(Pl. 6, figs. 11, 12)

A poorly preserved seed covered by an incrustation of pyrites which conceals all but its major characters. It is elongate-ovate, pointed at the base and narrowed towards the apex almost to a point. Dorsal surface convex longitudinally but not transversely with a small circular median chalaza. There is a shallow furrow between the chalaza and the base and apex. The ventral surface is sharply faceted with marked angular raphe ridge. The ventral infolds are short, occupying about half the length of the seed, situated at the middle. They are slightly concave to the raphe ridge. The margin between the two surfaces is angled. Length of seed 7 mm; breadth 4 mm; thickness 3 mm; V.51114 from the Upper Fish Tooth Bed, Bognor, described because, in spite of its poor condition, it has distinctive characters which would be recognizable again if found.

### Genus *AMPELOPSIS* Richard

#### *Ampelopsis crenulata* Reid & Chandler

(Pl. 6, figs. 13-16)

1933. *Ampelopsis crenulata* Reid & Chandler: p. 385, pl. 19, figs. 11, 12.

Typical seeds are now known from new horizons and localities.

**Description. Seed:** With some testa preserved (the holotype was a cast). The ventral face shows a profile the apical channel partly occupied by the raphe. The raphe ridge is a conspicuous feature and passes over the apex to the dorsal side. As the testa occupies their upper ends the ventral infolds are a little shorter than in the Holotype. Two or three lobes of the ventral surface diverge towards the apex from the upper end of each infold. Six and seven rounded lobes are seen on the dorsal surface on the two sides of the chalaza respectively. Length of seed, 4.5 mm; breadth 2.9 mm; thickness 2.5 mm. V.51075 from the Lower Aldwick Beds, Bognor. V.51076 has even more testa preserved and is a shorter broader seed (Pl. 6, figs. 15, 16) from the Beetle Bed, Bognor. Length 3.9 mm; breadth 3 mm; thickness 2.5 mm. Other specimens are V.51078, V.51079 from Warden and V.51077 from the Beetle Bed, Bognor. All seeds present such a highly characteristic appearance that their specific relationship is clear.

Genus *TETRASTIGMA* Planchon*Tetrastigma sheppeyensis* Chandler

(Pl. 6, figs. 17-20)

1961. *Tetrastigma sheppeyensis* Chandler: p. 255, pl. 25, figs. 26, 27.

Two seeds, the larger (V.51092) as described in the above reference, but the base which is pointed is complete. The apical channel is well marked and deep. The ventral facets are equal. There are eight radial ridges diverging from the chalaza. The seed appears to be undistorted (Pl. 6, figs. 17, 18). Length 4.1 mm; breadth 2.85 mm; thickness 2.25 mm. From the Lower Fish Tooth Bed, Bognor, a new locality. A smaller seed (V.51093; Pl. 6, figs. 19, 20) otherwise differing only in the absence of an apical channel. From the Upper Fish Tooth Bed, Bognor, a new locality.

## Family RHIZOPHORACEAE

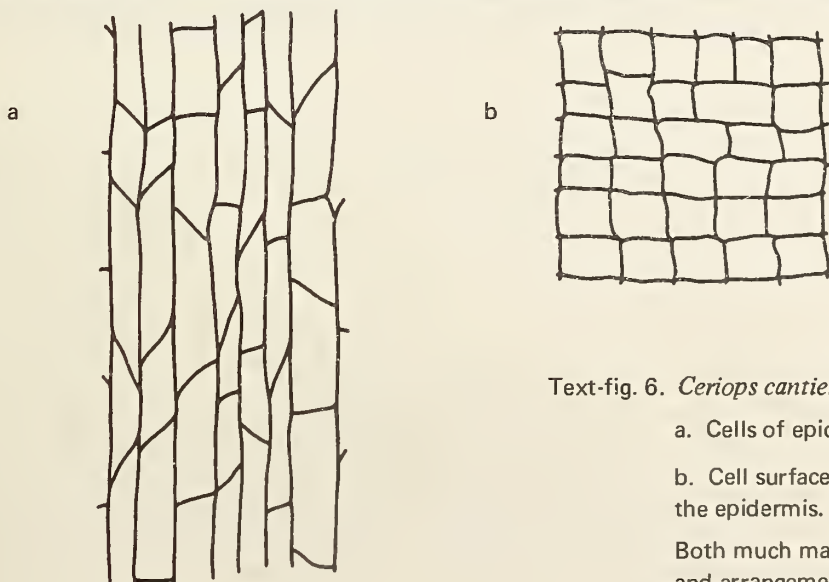
Genus *CERIOPS* Arnott*Ceriops cantiensis* n.sp.

(Pl. 7, figs. 1-9, text-fig. 6)

**Diagnosis.** Fossil embryos of the genus *Ceriops* with relatively thick hypocotyl adjacent to the plumule. Hypocotyl very sharply ridged longitudinally.

**Syntypes.** V.51650, V.51651.

**Description.** Embryo: Represented by the broken elongate hypocotyl tapering to a point at the distal end (V.30355, and Pl. 7, figs. 2, 4), truncate at the proximal end which bears a circular perianth scar from which the plumule arises (Pl. 7, fig. 1). Plumule represented by its broken folded leaves embedded in pyrites adhering to the scar. Hypocotyl sometimes flattened for part of its length (V.51130, V.30356), straight or curved, having from four to six sharp longitudinal ridges separated by concave areas. The concavities may have a low rounded median longitudinal ridge throughout their length (V.51130). Epidermis and immediately subjacent layers frequently preserved as carbonaceous tissues but sometimes pyritized in part. Surface with fine rugosities and intermittent transverse wrinkles or puckerings (Pl. 7, figs. 3, 4). In section these layers often appear as a columnar carbonaceous shell, about 0.057 mm. thick, which tends to crack and flake away on drying. The columnar appearance is due to the arrangement of the cells at right angles to the surface. External surface shining even over the rugosities. Epidermal cells seen where this surface is best preserved, formed of longitudinally aligned cells which also appear longitudinally elongate. Cell walls sunk and cell surfaces slightly convex; longitudinal walls more conspicuous than the transverse which may lie at right angles or oblique to the length so that the ends of the cells may be rectangular, pointed or bevelled when well preserved (text-fig. 6). The sunk walls

Text-fig. 6. *Ceriops cantiensis* n.sp.a. Cells of epidermis.  $\times \approx 1000$ b. Cell surface immediately beneath the epidermis.  $\times \approx 3000$ 

Both much magnified to show form and arrangement of cells.



give rise to a longitudinally striate appearance with striae about 0.034 to 0.046 mm. apart. The cells are at least 0.1 to 0.2 mm. long, or even apparently longer, but this appearance may be due to the obscurity of the less conspicuous transverse walls in places. On the specimen with plumule, although in places the surface is shining and complete it presents elsewhere an unusual appearance caused by the abrasion of the outer cell walls so that the cell cavities are exposed delimited by upstanding partially pyritized radial walls. Where this has happened the surface appears striate, not glistening, and finely longitudinally ridged, the normal surface rugosities being lost. Cells immediately beneath the epidermis are rectangular in outline, slightly broader than long (about 0.028 mm. by 0.019 to 0.022 mm.) and aligned in regular longitudinal rows. They thus produce a combination of fine longitudinal and fine transverse striae. They are often made conspicuous by shining pyrites casts of their cavities which in many specimens have been partly exposed by abrasion (text-fig. 6). They may show through the partially translucent longitudinally striate epidermis causing its cells to have transversely striate appearance. Beneath the layers described above and usually pyritized there are longitudinal rows of equiaxial inflated rectangular cells, 0.028 to 0.038 mm. in diameter (Pl. 7, fig. 7) often seen where the carbonaceous "shell" has flaked away. Inside again are the characteristic lines of globular cells, up to 0.058 mm. in diameter, arranged in longitudinal lines like short rows of beads (Pl. 7, fig. 9). These were described in 1961. They form a conspicuous feature in longitudinal sections owing to their shining pyrites internal casts. At the perianth disc the carbonaceous outer layers bend sharply over at right angles forming a fluted rim. Maximum length of hypocotyl preserved in V.51650 with plumule, 45 mm. Breadth at perianth end, 5 mm; maximum breadth at broken opposite end, 7 mm. The original specimens were 17 to 35 mm. long and 7 by 4.5 mm. to about 5 mm. broad. Two specimens with radicle end complete are 21 mm. long, 5 mm. broad and 37 mm. long, 6 mm. broad respectively. A recently discovered fragment was 50 mm. long. The somewhat flattened V.51130 was 37 mm. long, with maximum diameter at the middle of 8 mm.

**Remarks and affinities.** It is not surprising that no perfect specimens are known of these long slender embryos, nor is it remarkable that the plumule end, where in *Ceriops* the hypocotyl is most slender, has so often broken away. Specimens described in 1961 included eleven fragments, none perfect even at the tip. No plumule end was then known. V.51130 was later added to the collection and a number of other specimens were identified and returned to the finders. Seven more have now been registered (V.51650-56) thanks to the skilful collecting of Dr. H.P. WILKINSON and six of these are here illustrated. It can therefore be stated that the species is fairly common at Sheppey but appears to have been overlooked because of the somewhat insignificant appearance of the fragments until the late A.G. DAVIS recognized it as worth collecting.

The resemblance to *Ceriops* is very striking and was obvious to VAN STEENIS (1962: 278) who having, presumably, seen the description and illustrations of the then unidentified genus referred to it as ?*Ceriops*. Thanks to the generosity of the authorities at the Royal Botanic Gardens, Kew, dried material of *C. tagel* (Perr.) C.B. Robinson has been made available for intimate study and confirms this relationship. The genus ranges from the Indian Ocean to the West Pacific including East Africa. It extends into Australia. Only two species are known, both of which are purely tropical, one being restricted to tropical Asia. The species are separated on small differences in the flower structure. The flowers of the fossil are not known and the embryos are fragmentary. Nevertheless in view of the strong probability that a species of Eocene age located in Europe must inevitably be different from either of the tropical Asiatic living forms a specific name has been given viz. *Ceriops cantiensis* which may serve as a reminder of its peculiar geographical origin. WATSON (1928: 131) described the Malayan species as growing best near river mouths in areas inundated by normal high tides and extending to those only inundated at spring tides. In such situations it is able, he states, to regenerate itself and not merely to exist.

## Family COMPOSITAE ?

### Genus ?

(Pl. 7, figs. 11, 12)

**Description.** Achene: V.51658. Inconspicuously bisymmetric, more or less sausage-shaped but slightly curved in the plane of symmetry and increasing in diameter towards the apex. The curvature causes the outline in the plane of symmetry to be convex on one side and almost straight on the other. Sides ornamented with sixteen conspicuous, shining, rounded, longitudinal ribs which terminate just below an apical rim. Four ribs on the shorter, straighter side of the seed are narrower than the other. They converge towards one another and terminate at the basal end of the achene against a marked circular rim which delimits the attachment scar. This scar, measured from the inner edge of the rim is 0.19 mm. in diameter. The enclosed areole shows three projections (?ends of vascular tissue). The broader, apical, rimmed area is about 0.2 mm. in diameter and was perhaps associated with a pappus. A central projection may indicate a style base which is surrounded by coarse equiaxial cells. The carpel wall is carbonaceous and much polished by



abrasion. Where the structure is visible, inflated rectangular longitudinal cells about 0.08 mm. long, 0.018 mm. broad, are seen. Similar cells diverge from the apex below the rim. The carbonaceous integument is cracking as almost invariably happens in these London Clay fossils and a fragment of the apical rim has now broken away on the shorter side thereby exposing elongate longitudinally aligned cells. Where a rib is sectioned transversely the cells which form it are radially elongate and arranged. Within one broken ridge is a canal (?conducting tissue). The internal case (probably locule, possibly seed) is formed of smooth glistening pyrites with a fine, transversely striate surface and very small equiaxial cells. The relationship of these two structures is not clear. Length of achene 1.75 mm; breadth in plane of symmetry 0.8 mm; breadth at right angles to the above 0.7 mm.

**Remarks and affinities.** One specimen only. The ribbed achene with its two terminal, rimmed scars strongly recalls certain genera of the Compositae. Marked similarities are seen in *Senecio* and *Chrysanthemum* for example. Thus *Senecio jacobaea* and *Senecio cineraria* are comparable in size but the fossil is stouter and broader with more rounded ribs. Also the fossil achene is more distinctly curved. Transversely sectioned achenes of *Chrysanthemum myconis* show ribs of similar coarse, radially arranged cells and the species has comparable coarse cells at the bottom of the apical rimmed depression. In Recent species examined the longitudinal striation of the ribs is more conspicuous but it must be borne in mind the fossil has undergone much polishing by abrasion. No species or genus examined resembles the fossil in such close detail as to suggest generic identity. In view, therefore, of the enormous size of the family and the impossibility of closely examining all its genera and species no generic determination is attempted until more fossil material can be studied. In view of the age of the London Clay, even the family affinity may justly be regarded with suspicion but no closer resemblance has yet been found among living forms. The presence of the pyritized internal cast and other indications of pyritization, e.g. around the apical rim exclude the possibility, carefully considered, that this specimen is a Recent introduction.

## INCERTAE SEDIS

### Family ?

#### *Carpolithus anthozoiformis* Chandler

(Pl. 9, figs. 1-3)

1964. *Carpolithus anthozoiformis* Chandler: p. 125, pl. 4, figs. 12-25; text-fig. 6.

An additional exceptionally beautiful specimen from the Lower Aldwick Beds shows the actual fruit clearly exposed by the abrasion of the upper part of the persistent calyx. It indicates clearly that the fruit is superior, a matter left in doubt by previous evidence. It is somewhat laterally compressed, five-angled with rounded, irregular, longitudinal lobes. The digitate cells of the surface of the fruit are in places clearly displayed and may be 0.05 mm. long and 0.04 mm. broad, somewhat inflated on the surface, aligned in longitudinal rows. They are seen in section surrounding the actual fruit in Pl. 9, fig. 2. On the calyx between the longitudinal ribs large cells of irregular shape are visible but near the fibrous ribs exposed by abrasion in the thickness of the wall, longitudinal rows of small square cells are seen, some with oblique end walls. Length of whole specimen 4.5 mm; maximum breadth across calyx 2.8 mm. Length of fruit exposed above worn calyx 1 mm.

V.51670 is a small specimen (Pl. 9, fig. 3) 2.5 mm. long; 0.9 by 1 mm. broad (broadest in plane of symmetry) with ribs largely removed by abrasion, the pointed base is worn so that the small subcircular end of the enclosed fruit is exposed. Interlocking cells are seen between the remains of the ribs each of which may be built up of small angular equiaxial cells. The apex is obliquely truncate with small central rounded mucro from which obscure lobes or ridges diverge. Longitudinal rows of small square cells associated with fibres and exposed on the sides of the specimen and interlocking digitate cells seen elsewhere on its surface so closely resemble structures described in *Carpolithus anthozoiformis* that this specimen is regarded as an immature or worn fruit of the species.

#### *Carpolithus bellispermus* n.sp.

(Pl. 8, figs. 3-6)

**Diagnosis.** Carpel dehiscent by a longitudinal suture. Seed solitary, bisymmetric, sub-oboval in outline but truncate at hilar end, apparently campylotropous, gently convex on broad surfaces parallel with plane of symmetry. Micropyle prominent, adjacent to excavated hilar scar. Testa formed of tubercles with digitate outlines, diverging from micropyle,

diminishing in size at hilar end, not visible on inner surface as in *Actinidia*, columnar in section. Inner surface of fine equiaxial cells only about one-third the size of the surface tubercles. Length of seed 3 to 3.15 mm; breadth parallel with plane of symmetry 1.75 to 2.25 mm; thickness 0.75 to 1 mm.

**Holotype.** V.51663

**Description.** Carpel: Represented by part only of the endocarp, having a longitudinal suture with rounded edges along which splitting has occurred. It embraces a single, usually inflated seed. The surface of the carpel on one side, is formed of cells, about 0.025 to 0.05 mm. in diameter, with coarsely sinuous outlines. These cells diverge from the suture. The abraded surface on the other side shows equiaxial pits about 0.025 mm. in diameter. In section the wall is columnar. Length of carpel preserved (incomplete at top and bottom) 3 mm; breadth 2.25 mm; thickness 1.5 mm.

Seed: Bisymmetric, elongate sub-oboval in outline, somewhat compressed at right angles to the plane of symmetry. Usually gently convex on the broad surfaces (subparallel with the plane of symmetry) and roundly angled marginally. Probably campylotropous with embryo sharply curved around an oblique axis. If anatropous the raphe has not been located. The outline is truncate or slightly excavated at the hilar end by a large, narrow, basin-like attachment area, now filled with pyrites, with central hilum. The micropyle is adjacent to one end of the hilar scar in the plane of symmetry. It is conspicuous by its prominence (Pl. 8, figs. 3, 5, 6). It shows an aperture with raised rim from which the surface cells of the seed diverge. Surface of testa formed by conspicuous tubercles with digitate outlines which diminish in size towards the hilum and micropyle and are mostly equiaxial but elongate towards the margin. The largest of these tubercles (or cells) are about 0.057 mm. in diameter. Testa columnar in section, ribbed columns being formed by the digitations; thickness 0.07 mm. Inner surface formed of small equiaxial cells about 0.018 mm. in diameter. Cells of surface of hilar scar similar but inflated. The larger, digitate tubercles of the outer surface are not represented by corresponding outlines on the inner surface of the testa as in *Actinidia* which the seed somewhat resembles in shape. Length of seed 3 to 3.15 mm; maximum breadth 1.75 to 2.25 mm; thickness 0.75 to 1 mm.

**Remarks.** Five specimens from the Beetle Bed, Bognor (V.51664-66, the other two specimens now decayed). The resemblance to *Actinidia* is purely superficial. There is no connection between the two. *Actinidia* is an anatropous seed. It lacks the conspicuous, deep, large hilar cavity which truncates the seed in the species here described. Its testa shows superficial straight-sided pits, their walls penetrating throughout its thickness. Hence their outlines are clearly visible on the inner surface where equivalent, although convex, areas (cells?) are seen. Unfortunately, as it has not been possible to discover the relationship of this species, it has been described as *Carpolithus*.

The campylotropous character is suggested by the absence of any indication of a raphe and the close proximity of hilum and micropyle combined with the character of the rounded, opposite end of the seed where there is no indication of chalazal structure.

### *Carpolithus* sp.

(Pl. 8, figs. 1, 2)

**Description.** Fruit: V.51662. Rounded triangular in outline, bisymmetric, flattened at right angles to the plane of symmetry; consisting of a fruit body seated upon a wing-like structure which projects beyond it at the sides but has a rounded obtuse end about 1.5 mm. above the narrow base (Pl. 8, fig. 1). Wing slightly emarginate at the apex, the fruit body having a short, low, pointed extremity visible beyond it in the emargination. Edge of wing inrolled towards the fruit body, longitudinally striate but the striae follow the margin of the wing at the curved, broad end. On the opposite side of the specimen (Pl. 8, fig. 2) the wing is flat, transversely puckered, probably thin and diaphanous in the original, again finely longitudinally striate the striae diverging from a well defined line below the projecting tip of the fruit. Remains of a carbonaceous coat, obscurely pitted on its outer surface, still adhere, the pits being coarser than the striae. The striae coalesce towards the lower end and there is also evidence of fine, irregular, transverse striations and elongate cells with oblique end walls. The projecting broader end of the fruit itself as seen from this side has a median longitudinal flat rib. Fruit body pointed at both ends, having a median longitudinal flat nerve on its exposed surface from which at its lower end sharply sinuous branches arise and diverge over the flat surfaces flanking the rib (Pl. 8, fig. 1). It is not clear whether these are part of the fruit wall or are closely adherent but free tortuous hairs. Length of whole specimen 5.5 mm; maximum breadth 2.5 mm; thickness 1 mm.

No comparable living genus has been seen. From the Beetle Bed, Bognor.



*Carpolithus* sp.

(Pl. 8, fig. 7)

**Description.** Achene: V.51667. Bisymmetric, originally two-valved, valves meeting in plane of symmetry but one now missing. Obovate in outline, flattened, having a wide, marginal furrow in plane of symmetry. A small triangular prominence at the broad end to one side of the longitudinal axis probably indicates a style. There is no clear evidence at the narrower end of an attachment but the shape suggests that it may have occupied this position. Surface ornamented with low rounded tubercles which tend to coalesce at their bases to form deep depressions. Between the tubercles fine elongate cells or fibres are seen arranged in parallel groups forming a criss-cross pattern. The cells tend to diverge around the tubercles. A predominant transverse or oblique striation may be due to an outer layer of cells with this alignment with an underlying layer otherwise orientated which gives rise to the criss-cross effect. One valve of the achene has flaked away exposing elongate cells about 0.01 mm. broad forming oblique impressions on the locule lining. In one minute patch beneath, again there are remains of a very finely pitted coat (? testa of seed). Similar cells on the smooth surface of the stylar area are angular, slightly irregular in size and shape but on the whole about 0.018 mm. in diameter. Length of achene 4.25 mm; breadth just above the middle 3.25 mm; thickness with one valve missing 0.75 mm.

It has not been possible to determine this specimen which somewhat resembles the achene of a buttercup, but the cell structure excludes this relationship. From the Upper Fish Tooth Bed, Bognor.

*Carpolithus* sp.

(Pl. 8, figs. 8, 9)

**Description.** Seed cast: V.51668. Bisymmetric, much compressed at right angles to the plane of symmetry, rounded subquadrangular in outline although slightly narrower towards one end where it slopes towards a pointed radicular prominence. Opposite end truncated by a shallow emargination in which the chalaza lies, probably anatropous as indicated by a longitudinal fibre strand which occupies a shallow, median longitudinal hollow on one broad surface although it seems to be abraded towards the radicle. Hollow flanked on this surface by marginal longitudinal convexities (Pl. 8, fig. 8). On the opposite broad surface a sharply defined, deep, median longitudinal groove suggests the adjacent margin of two cotyledons which lie side by side. The groove ends at about 1 mm. below the tip of the radicle. Surface of cotyledons on both sides of the groove having a very slight longitudinal channel (Pl. 8, fig. 9) but otherwise gently convex. On the opposite raphe side of the seed a short but similar groove extends from the tip of the radicle for about 0.5 mm. onto the cotyledons but on this side the junction between them is elsewhere obscured by the adherent raphe. It lies nearer to the more convex side of the cast than to the raphe side and is pointed towards the convex side, elsewhere rounded. Over most of the surface the cell structure is obscure but on the more convex surface thin walled angular cells are seen partly hidden by remains of a coat of minute granular equiaxial cells. Towards the chalaza the cells of the cast tend to be elongate and are aligned in longitudinal rows. Length of cast 2.9 mm; maximum breadth 1.8 mm; thickness 0.75 mm.

**Remarks.** The form of this specimen (V.51668) from the Lower Fish Tooth Bed, Bognor and the apparent arrangement of its organs suggests that it is the embryo of an exalbuminous seed (virtually therefore a seed cast). The presence of a raphe, if correctly interpreted, suggests that the radicle marks the base of the seed for in anatropous seeds it, and therefore the micropyle, would be closely associated with the hilum. The position of the cotyledons side by side on the broader surface is a rare one. In the majority of Recent exalbuminous seeds of this form, the cotyledons are superposed, each occupying the full breadth and lying at right angles to the plane of symmetry.

A possible alternative interpretation is to regard the cotyledons as superposed in the broader plane (as in most seeds) and the median longitudinal furrows described as representing very thin, incomplete septae. The convex surfaced cotyledon, on this interpretation, has a pair of primary lobes as in Juglandaceae but they lie unusually close together and are separated by an extremely thin shallow septum. The scar at the base of this surface must then be regarded as the hilum, not the chalaza, while the longitudinal fibrous tissue on the opposite (upper) face would be part of the endocarp as in *Pterocaryopsis* (p. 19). As no Juglandaceae genus has been seen, whether living or fossil, with such closely approximated primary lobes and such an extremely shallow hilar excavation, the specimen is for the time being described as *Carpolithus* sp. while awaiting the discovery of more illuminating fossil material.

### Tuber or Swollen Root

(Pl. 9, figs. 4, 5)

V.51671 is part of a tuber or swollen root from the Lower Fish Tooth Bed, Bognor. It had been broken longitudinally before fossilization and at first sight suggests a pod-like fruiting organ. The exposed inner surface nevertheless makes it clear that it cannot be a pod for it is solid throughout and formed of coarse parenchyma. It has broken in such a manner as to show, on the fractured surface, two longitudinal facets meeting at a wide angle along the core of the tuber. This also displays a stout, longitudinal, median fibre (Pl. 9, fig. 5). The external surface is gently convex and finely rugose with a thin black skin. The outline is fusiform; pointed at one end but slightly incomplete at the other which simulates the broken attachment end of a pod. There is a flat strand of fibres externally occupying a median longitudinal position (Pl. 9, fig. 4). Both exposed surfaces are much obscured by films of pyrites. Length of specimen 29 mm; maximum breadth preserved 13 mm; thickness of the fragment 5 mm.

### Tap Roots

(Pl. 9, figs. 6-11)

**Description.** Two swollen, elongate, subcylindrical tap roots (V.51672-73) represented by their upper ends (at or just above ground level) with the growing point worn or broken so as to expose the central core of parenchyma. The lower part in each case is missing as it was ground away by the finders before the specimens were presented to the Museum, consequently the full shape and length of these organs is not known. The truncated upper end shows the core as a circular parenchymatous area about 20 mm. in diameter in the larger root, 16 mm. in the smaller. This is surrounded by a single or double row of sunk scars elongate concentrically and from 3 to 14 mm. wide in this direction, 2 to 3 mm. wide radially. These are presumed to be leaf bases, for traces of the cut ends of a few vascular strands represented by pits are seen although usually obscured by the pyrites which fills these depressions. Near the circumference of the central area, about 2 mm. from its edge, is a ring of similar pits indicating vascular tissue of the root itself. The sides of both specimens are puckered with rounded longitudinal ridges of irregular length and width probably due to shrinkage of the inner tissues on drying. There are indications of transversely aligned superficial cells but they are much obscured by polishing or abrasion on the ridges and by pyrites within the hollows between the ridges. The cut lower end of the larger root shows a core like the apex about 20 mm. in diameter formed apparently of parenchyma but all much obscured by a dark infilling of pyrites. Outside the core the tissues show an irregular, obscure, concentric arrangement. There is much cracking both concentrically and radially, the abundant cracks being occupied by infiltrations of light coloured pyrites which make these outer layers conspicuous in contrast to the dark tissues of the core (Pl. 9, fig. 8).

The smaller specimen has a broken apex on one side but what remains shows a double ring of leaf scars. Drying and cracking have proceeded further in the root for there are repeated concentric lines of light pyrites of irregular width and spacing, not all being strictly parallel. Numerous radial cracks, similarly pyrites-filled are also present. They are equally irregular. Even the central core is cracked, the cracking having occurred in an excentric manner. (Pl. 9, fig. 11).

Total remaining length of larger root, 42 mm. Maximum diameter (at 20 mm. below the apex), 35 mm. Diameter across the cut lower end 28 mm. Remaining length of smaller root 26 mm. Maximum diameter at the upper end, 16 mm. Diameter of the cut end 35 to 36 mm.

**Remarks.** The cross section showed that these objects could not be fruits. Their solid character throughout, and the presence of leaf scars at one end indicated tap roots. The amount of concentric cracking on drying, made conspicuous by the pyrites infilling, differentiates them from such roots as carrot (Umbelliferae) or turnip (Cruciferae) but makes them more comparable with beet (Chenopodiaceae) but unlike beet there is no regularity of the concentric or radial structures. It has not been possible to identify them. There is little collected information or material available about plants with roots of this type.

### Branched Spines

(Pl. 9, figs. 12, 13)

Two spiny fragments of ? twig are of unknown affinity (V.51674-5). One, having three spines flattened in the same plane as the twig, is 4.5 mm. long, with an overall breadth of 2 mm. Spines all slightly recurved in the same direction, triangular with bases about 1 mm. in width where they join the twig. The other specimen is 7 mm. long tapering to the pointed tip with two large scarcely recurved spines (bases 0.75 mm. broad; length 1.5 mm.) and two short spines



nearer the tip (one incomplete). The plant nature is demonstrated by the cell structure of the broken ends of the spines showing relatively coarse radial cells. Surface structures entirely hidden by a film of featureless pyrites. Beetle Bed, Bognor.

### Unidentified Dicotyledonous Twig

(Pl. 10, figs. 1-3)

A small abraded undetermined dicotyledonous twig V.51677 from Sheppey is included to illustrate the need for caution in the determination of some of these worn pyritized specimens. The twig is part of an internode, somewhat compressed. It shows superficial slightly grooved, longitudinal ridges alternating with deep furrows. It therefore bears a marked resemblance to *Equisetum* stems as sometimes preserved in which ribs represent the casts of cortical cavities, subcuticular thickening opposite to them causing shallow longitudinal grooves on the ribs (cf. REID & CHANDLER 1926: 44, pl. 2, figs. 1, 3). Examination of the broken ends of this stem dispels the illusion. The ridges are then seen to be the worn outer ends of medullary rays alternating with the sunk ends of the xylem arranged radially between them, the whole being exposed by removal of superficial stem tissues before pyritization. The cross-section shows the rectangular cells of the rays about six cells deep at the exterior with the primary xylem tissue in between formed of large pyrites filled sub-circular vessels surrounded by parenchyma. In the superficial furrows spirally thickened vessels can be traced for short distances only owing to uneven wear and tear. The twig fragment is 19 mm. long, with a maximum diameter of 9 by 6 mm.

## 2. THE BARTON BEDS

### ANGIOSPERMAE

#### Class DICOTYLEDONES

#### Family ANONACEAE

Genus *ANONASPERMUM* Ball emend. Reid & Chandler 1933: 184

#### *Anonaspermum* sp.

(Pl. 19, figs. 1, 2)

**Description.** Seed: Bisymmetric, ellipsoid but somewhat broader in the plane of symmetry than at right angles to it. Testa much worn and rotted, flaking and cracking in places to show the sunk marginal raphe in the plane of symmetry (Pl. 19, fig. 1) and small patches of the ruminations in the albumen (Pl. 19, figs. 1, 2) where short intermediate ruminations can be seen at the margin between longer ones. Length of seed 15 mm; breadth 12 mm. in plane of symmetry; thickness at right angles to this 10 mm.

**Remarks and affinities.** The carbonaceous seed is of approximately the same length as the largest pyritized seeds of *Anonaspermum commune* (REID & CHANDLER 1933: 184, pl. 5, figs. 14-17) from the London Clay. It is broader and more inflated than that species. It must be presumed to have been considerably larger originally as in carbonaceous specimens considerable shrinkage invariably occurs. It is also larger than *Anonaspermum* sp. believed also to come from the Barton Beds (CHANDLER 1960: 225, pl. 34, figs. 110-113) (Length 9 mm; breadth 7 mm; thickness incomplete). This seed, in which the ruminations were much better exposed, was compared tentatively with *A. rugosum* Reid & Chandler (1933: 182, pl. 5, figs. 21-24), another London Clay species. Too little is known of the newly discovered seed for specific determination.

After the upheavals of the war years, the seed described in 1960 could not be traced and was presumed to have decayed. It was found much later and registered V.29217. A second record of Anonaceae in this part of the Hampshire coast section, this time undoubtedly from the Barton Beds is useful confirmation that this tropical family was indeed represented at this period of the history of our Lower Tertiary vegetation.

### 3. THE HAMSTEAD BEDS

#### Introduction

The plants described on pp. 38-44 are an important addition to the limited Isle of Wight Lower Tertiary Flora. Their discovery is a result of the initiative and persistent effort of Mr. R.L.E. FORD. In view of the mode of occurrence it is not surprising that they have been overlooked by earlier collectors, for difficult and uncomfortable conditions are encountered both in reaching the site and in working at it. In addition the specimens are out of sight for most of the year below the sea. The Geological Survey memoirs are largely concerned with the variation and thickness of the Hamstead Beds as displayed in the cliff sections. Scant attention appears to have been paid to wide exposures of these beds below tide level. The newly discovered plants have so far been found only along a short stretch of coast below Bouldnor cliff, some two and a half miles east of Yarmouth where the coast line faces north-west. Owing to lack of permanent features on the spot caused by the rapid changes perpetually taking place on this unstable coast it is difficult to pin-point the position precisely. It lies between an old pier-base about a mile and a furlong from Yarmouth pier on the west and a line of posts marking the site of a former submarine net on the east, where the land at present projects as a point to the sea. It is thus opposite the words "Corbula Beds" printed on the Geological Survey 1" map (New Series, parts of sheets 330, 331, 334, 345. 1926 edition. Revised 1935) but in the foreshore, not in the cliff. At low water a pavement of clay is exposed throughout this stretch of coast which may be covered to a variable degree by shingle. Among the shingle there are abundant ironstone slabs (two of which yielded palm leaves; V.45000 and V.51693 pp. 42-43), fragments of pyritized wood, bones, teeth and shells but none of the determinable cones and twigs now to be described. These so far have been found at extreme low water and only in a little bay between two marked platforms of Hamstead Beds. The actual site for collecting is best exposed after winter storms have cleared much of the sand and shingle normally present and is accessible only in spring and autumn when the tide fall is at its maximum (height in Tide-Tables 12 feet 3 inches). Even then it is restricted to about an hour on each side of low tide. There is clear evidence at this point of local tectonic activity. A conspicuous fault trench crosses the platforms which flank the little bay. On the seaward side of the fault there are somewhat indurated clays with fine sandy partings dipping only slightly seawards. Some of the bedding planes are made conspicuous by abundant uncrushed valves of *Polymesoda convexa* (Brongniart) [formerly *Cyrena semistriata* Desh.]. On the landward side of the fault the softer, smoother clays dip steeply. Lines and lentils of broken and crushed shells mingled with seeds of water plants are common, while the upturned edges of the strata planed by the sea show pyrites plates still *in situ* sometimes only partially formed and hardened by the action of the sea water. Patches of pyrites have been eroded and concentrated by wave action in the fissures and joints of the clay. Much of the pyrites is grotesque in appearance and some is purely concretionary in origin. Among such pyrites concentrations a palm leaf (V.51693) and the *Sequoiadendron* cones and twigs were found. Some of these have been crushed and flattened prior to pyritization and they may be presumed to come from disturbed strata like those described above. Other specimens are uncrushed. One carbonaceous cone only slightly pyritized was found by Mr. FORD *in situ* while digging a hole in the slightly inclined strata in one of the platforms. He also extracted a *Pinus* cone *in situ* projecting from the clay. Apart from these two specimens and the abundant small seeds of water plants already mentioned, the remains are drifted, not *in situ* but there appears to be no doubt that all come from the Hamstead Beds. By sifting seams with seeds Mr. FORD obtained abundant *Aldrovanda intermedia* (V.51818-20), *Stratiotes acuticostatus* (V.51817), *Rhamnospermum bilobatum* (V.51787) and large specimens of *Brasenia ovula*. As these fossils are not found at normal tides when the low water mark is higher up the beach their concentration is probably not due merely to specific gravity without regard to their source. For the same reason it appears unlikely that they are derived from the wastage of the subaerial cliffs behind. But they appear to be more abundant after storms so it is probable that some at least come from beds at and perhaps somewhere below the lowest tide level. This fact combined with the rare recent discovery of cones *in situ* seems further to indicate that the pyritized plants come from below tide level and that the Hamstead Beds are the source of supply.

Examination of the pyritized specimens shows that the majority have a coating or incrustation of amorphous pyrites which conceals their surface features in varying degrees. Large cones with peltate scales are the most abundant. One such was fractured (Pl. 11, figs. 1, 2). It shows on the sectioned surface not only the protective coat of pyrites covering the whole of the exterior but infiltration and consolidation of similar pyrites between the scales themselves cementing all firmly together. In some specimens the pyrites incrustation is so thin that the ornamentation of the escutcheons is clearly reproduced upon it with only a limited rounding of the original irregularities (Pl. 10, figs. 6-10). In other cones the incrustation may be much thicker. It sometimes even masks the junction of adjacent scales. A further accretion of pyrites may produce featureless protuberances over the scale surfaces which may completely hide all details of the escutcheons beneath (Pl. 10, fig. 11). Although scattered crystals of pyrites can be seen among the carbonaceous tissues of the sectioned cone (as in much carbonaceous material preserved in freshwater beds from elsewhere) there is no sign of replacement of organic structure cell by cell as in the London Clay plants. An entirely different type of pyritization is here represented. While the causes of pyritization are not fully understood, it is very frequent where organic matter has



drifted long in sea water. Hence it is not an unusual type of preservation in marine strata.

After being washed out of the matrix some at least of the plants have lain on the sea bed long enough for small colonies of polyzoa to grow upon them. The carbonaceous cone mentioned above shows an acorn barnacle on one surface. Coniferous twigs densely clothed with long spirally arranged curved leaves are similarly incrustated with pyrites which usually conceals all but the form, size and arrangement of the leaves. In one important twig impressions of stomatal bands were seen in pyrites and one or two of the actual carbonaceous leaves were partially exposed. In spite of their rotten condition it was possible to make a poor cuticle preparation (V.51680a) from one such leaf. The slide shows the important features described on p. 39. Unfortunately this cuticle began to break up during permanent mounting and is therefore partly disorganized. For this reason too, it could not be thoroughly cleaned prior to mounting and it seemed better to make sure of some evidence than to lose it all in seeking to produce a better preparation. The data afforded by this twig provide a solution to part of a long standing palaeobotanical problem. The growth of the leaves on the twig, their shape, size and cuticle structure accord so closely with barren foliage from Bournemouth, hitherto described as "*Araucaria goepperti*" by GARDNER (or "*Araucarites sternbergi*" by CHANDLER), as to indicate certainly their generic and probably their specific identity. An unlabelled carbonaceous twig (V.51681) in whitey-gray sandy clay matrix preserved in the British Museum (Natural History), previously referred on account of this matrix to ?Hamstead Series, agrees closely with the pyritized Hamstead twigs and the carbonaceous ones from Bournemouth (Pl. 12, figs. 3, 7). V.51681 shows not only comparable foliage but has three young attached *Sequoia*-like cones closely resembling a Hamstead twig with young cones (V.51696) in the position of growth (cf. Pl. 12, figs. 3, 4; Pl. 12, fig. 7).

For reasons given on pp. 39-40 the large cones associated with the pyrites covered foliage are referred to *Sequoiadendron*. The association of these cones of Sequoian affinity with foliage so similar in form and cuticle structure to the Bournemouth *Araucarites* at last indicates the true relationship of the Bournemouth specimens of this problematical genus now referred with the Hamstead cones and foliage to *Sequoiadendron*. Some forty years ago BANDULSKA examined cuticles of this Bournemouth material. Although she finally allied it with *Araucaria* (BANDULSKA 1923: 248) she saw and commented on the resemblance to *Sequoia*. Only after long deliberation was the decision in favour of an Araucarian affinity taken. Later CHANDLER (1963: 39, pl. 1, figs. 1, 2, 4-13; pl. 2, figs. 1-3, 6-10; pl. 7, fig. 14; text-fig. 8) redescribed this cuticle from more extensive fragments retaining the name *Araucarites* but using the specific name *A. sternbergi*. The similarity of the Bournemouth cuticle to *Sequoia* was again noted on a number of occasions while working on *Sequoia couttsiae*. CHANDLER commented as follows (1962: 21): "Certain similarities between the cuticles of *Sequoia couttsiae* and *Araucarites* [from Bournemouth] may be noted, for when only very small scraps of cuticle are examined it is not always very easy at first to distinguish between them. In both, large stomata occur with large thin guard cells and a conspicuous pore. In both a ring, or a double ring of auxiliary cells placed end to end surround the stomata and show no clear separation into polar and lateral cells. *Araucarites* cuticle is usually coarser and thicker-walled than that of *Sequoia couttsiae* and its stomata are larger. The outer pore of *Araucarites* is frequently broader relative to the length than that of *S. couttsiae*." The newly discovered material gives added point to the above remarks and we may now presume that the Bournemouth *Araucarites* belongs to the Taxodineae so that true Araucarian affinities can no longer be claimed for it. Unlike *Sequoia couttsiae*, the species is referable to *Sequoiadendron* rather than to *Sequoia sensu stricto*; not only the generic but the specific name now calls for revision. The genus *Araucarites* was instituted by PRESL (in STERNBERG 1838: 203) for *Araucaria*-like coniferous remains, both cones and sterile branches, and serves a useful purpose. The original species, *Araucarites goepperti* Presl (a specific name adopted by GARDNER for the Bournemouth sterile branches) was founded on a detached and imperfectly preserved cone from the Tertiary of Haring in Tyrol. GARDNER (1883-86: 96, fig. 37) reproduced a figure of this cone. GOEPPERT (1850, pl. 44, fig. 1) used the specific name *A. sternbergi* for the sterile twigs which he described from the same locality. While regarding the cone as belonging to the same species as the twigs, GOEPPERT felt obliged to give a separate name until proof of his idea was available. It seems therefore that without obvious justification GARDNER (1884 pl. 11, fig. 1) figured the sterile Bournemouth twigs under the name *Araucaria goepperti* Sternberg. SEWARD (1919: 268) later advocated retaining the specific name *sternbergi* for this type of foliage with relatively long, narrow, somewhat spreading and falcate leaves. The connection of the original cone and the twigs from Tyrol still remains uncertain. Nor is there any cuticular evidence from Haring to establish its identity with the Bournemouth foliage. It therefore appears desirable to give a new specific name to the Hamstead foliage and probably to the Bournemouth also. No more appropriate name can be suggested than that of the finder of these illuminating Hamstead plant remains. Hence the name *Sequoiadendron fordii* in the systematic section on p. 38.

Although there is a marked resemblance between the cuticles of *Sequoiadendron fordii* and the two British species, *Araucarites gurnardii* from the Bembridge Beds and *A. selseyense* from the Lutetian and Auversian Beds of Sussex, the three cuticles are quite distinct, at least specifically, as pointed out by CHANDLER (1961a: 23; 1963: 39). While all may belong to the Taxodineae rather than to Araucarineae some other genus or genera may be represented in the case of the Selsey and Bembridge conifers. At present there is no conclusive evidence.

Up to date, apart from *Rhamnospermum*, *Brasenia*, *Stratiotes*, *Aldrovanda* and an unnamed small palm fruit the only other plant remains from the new site under discussion are: (1) cones of *Sequoia couttsiae* which present a very different appearance when placed side by side with the cones of *Sequoiadendron fordii*. (2) A cone of *Pinus fordii* n.sp. (3) The central part of two leaves of *Sabal* beautifully preserved on both surfaces. They may be ironstone replicas of the hollow formerly occupied by a leaf which subsequently decayed but remains of leaf tissue still adhere to both surfaces of the cast. (4) A curious flower-like structure with ovary and anthers. The predominance of *Sequoiadendron* and presence of *Pinus* and *Sequoia couttsiae* suggests derivation from an upland site. Perhaps after lying on the ground beneath the trees these cones and twigs were swept by heavy rainwash into a flooded river by which they were carried rapidly to the sea.

A few much encrusted cones, poor plant remains and a small cone of *Pinus* sp. were found on the shore nearer Yarmouth below "The Warren". There was also a second specimen of ?*Pinus fordii* *in situ* near the Defence Boom at Newtown River.

### SYSTEMATIC DESCRIPTIONS

#### GYMNOSPERMAE

#### Order CONIFERALES

#### Family TAXODINEAE

#### Genus *SEQUOIADENDRON* Bucholz

#### *Sequoiadendron fordii* n.sp.

(Pl. 10, figs. 6-11; Pls. 11; 12; Pl. 13, figs. 1, 2, 4, 5; Pl. 14; Pl. 17, figs. 2, 3)

1850. ?*Araucarites sternbergi* Goeppert: pl. 14, fig. 1.  
 1883. ?*Araucaria goepperti* (Sternberg): Gardner p. 55 (1884), pl. 11, fig. 1; pl. 12.  
 1923. ?*Araucarites goepperti* (Sternberg): Bandulska p. 248, pl. 20, figs. 13, 14.  
 1926. ?*Araucarites sternbergi* Goeppert: Florin *in* Reid & Chandler p. 48.  
 1963. ?*Araucarites sternbergi* Goeppert: Chandler p. 29, pl. 1, figs. 1, 2, 4-13; pl. 2, figs. 1-3, 6-10; pl. 7, fig. 14; text-fig. 8.

**Diagnosis.** Twigs densely clothed with spirally arranged, decurrent long, curved, falcate leaves; cuticle structure as in "*Araucarites*" from Bournemouth. Young twig tips with shorter, scale-like imbricate leaves. Ovuliferous cone ellipsoid, with about thirty to forty spirally arranged peltate scales having a thick body and slightly convex escutcheon. Escutcheon commonly almost as high as broad, often quadrangular, less frequently pentangular or hexangular, with central mucro, sometimes with transverse median ridge, commonly with fine radial ridges. Largest ripe cone about 35 mm. long; 23-30 mm. broad. Seeds inverted: outermost seeds attached some distance below margin of escutcheon.

**Syntypes.** V.51694, now decayed, V.51696 now decayed, V.51680, V.51701.

**Description.** Twigs: Larger twigs clothed densely with spirally arranged, decurrent, long, curved falcate leaves as in the Bournemouth species of *Araucarites* (Pl. 12, figs. 5, 6; Pl. 13, fig. 3). Leaves quadrangular in transverse section. Smaller twig tips with shorter, more closely appressed scale-like leaves. Thickest twig about 56 mm. long, somewhat flattened, having a maximum width including its leaves of 18 mm. in plane of flattening. V.51680 shows the base of a lateral branch (now broken) (Pl. 12, fig. 2). This twig is about 60 mm. long (incomplete at both ends) and 12 mm. broad. A few carbonaceous leaf remains project through the incrustation of pyrites which covers the specimen. One of these yielded the cuticle fragments described below. The tips of the leaves are usually broken so that the full breadth of the twig must have been greater. V.51679 (Pl. 12, fig. 1) is 70 mm. long, was originally branched but again the branches are broken. Its maximum breadth is ca. 17 mm. Other twigs are much obscured by a dense covering of pyrites. A specimen in Mr. FORD's collection shows three twigs cemented together by pyrites; maximum length 48 mm; width of broadest twig about 11 mm. (Pl. 13, fig. 2). V.51696 bears two small immature cones (Pl. 12, figs. 3, 4) both pyrites coated, the larger about 20 mm. in diameter, the smaller 10 mm. Longest exposed free (i.e. not decurrent) parts of leaves 7 to 10 mm.



**Cuticle:** (Pl. 13, fig. 5; Pl. 14, figs. 1-4). In spite of the fragmentary remains of this much rotted material certain distinctive features are well shown. Stomatal bands on both surfaces of the leaf extend almost to the tip. There are two bands on the upper and two on the lower surface. The cuticle of the lower surface (Pl. 14, figs. 1, 2) is slightly denser than that of the upper especially near the lateral angles where the ordinary epidermal cells of the marginal bands tend to be a little narrower than elsewhere and longer than those of the upper surface. The ordinary epidermal cells where elongate have a distinct tendency to narrow towards their extremities which may therefore be angled, pointed or oblique. Obscure pits are seen in places. Most of the stomata on both surfaces are obliquely orientated but longitudinal and transverse orientation may occur. A fragment of cuticle near the base of the upper surface shows a larger proportion of transversely orientated stomata, four such are closely adjacent in the same longitudinal line (Pl. 13, fig. 5). The line may have been longer but the fragment ends at this point. Most of the stomatal pores are obscured by sand or fungi and the whole tissue was too fragile to be handled more than was strictly essential. The guard cells are therefore mostly hidden but the inner pore in the larger stomata is about 0.04 to 0.045 mm. long. Around the pore is a line and in places a double line of auxiliary cells arranged end to end (Pl. 14, fig. 2). No auxiliaries are shared by adjacent stomata although they are frequently contiguous. A characteristic appearance is produced by two such adjacent transversely aligned auxiliaries between transverse or obliquely oriented stomata. The ordinary epidermal cells of the stomatal bands are irregular both in shape and size. They may be quadrangular, or pentangular, sometimes sexangled. They are often as long as broad and may be broader than long especially between neighbouring stomata in one row or between the stomata of adjacent rows. The structure is in close agreement with that of "*Araucarites goepperti* Gardner" ("*Araucarites sternbergi* Chandler") from the Bournemouth Beds.

**Cones:** Reasonably well preserved cones have been found and there are others too much encrusted with pyrites to show their detailed sculpture clearly. They are ellipsoid, borne on short stalks which arise laterally from stouter woody twigs showing the scars of decurrent leaves (Pl. 11, fig. 3, Pl. 13, fig. 4). The scales are peltate and spirally arranged around a stout axis (7 mm in diameter in a transversely fractured cone). The cone scale is thick becoming thicker distally, the escutcheons have flat or gently convex surfaces. They meet edge to edge in closed cones but gape in mature specimens, even in smaller specimens which have dried out before fossilization (Pl. 10, figs. 6, 7; Pl. 17, fig. 3). One of the smaller but the most perfect cone showed about thirty-three scales. A well preserved larger cone had forty scales but it was not really possible to count with certainty the tiny scales at the extreme base and apex in either case. The escutcheons are almost as high as broad, tending to be a little broader transversely, i.e. at right angles to the length of the cone. Each has a central mucro, some show a median transverse ridge. An immature pedunculate cone, 26 mm. long, 23 by 19 mm. broad with well preserved escutcheons (Pl. 17, fig. 3) shows a conspicuous, tapering tongue-like median mucro, 2 mm. long. It has shrivelled in more mature specimens. Slight radial ridges or puckerings diverge from mucro or ridge towards the margins where cell structure is radially aligned. In almost all specimens the surface features are rendered less sharp by a film of accrescent pyrites. One partly unencrusted, carbonaceous cone (V.51682) (Pl. 17, fig. 2) displayed the escutcheon characters modified only by the cracking and shrinkage such as normally occurs in carbonaceous material. This shrunken cone is 26 mm. long with a maximum diameter of 24 mm. Typical escutcheon measurements in pyritized cones are: height, 8 mm, transverse breadth, 13 mm; height, 5 mm., breadth, 10 mm; height, 7 mm., breadth 10 mm. In immature cones the height varies from 4.5 to 8 mm. and the transverse diameter from 7.5 to 9.5 mm. At least one specimen (Pl. 11, fig. 8) shows escutcheons which have burst open exposing disintegrating internal tissues and resin as in rotted Recent cones which have been subject to much abrasion and decay. The rotted scales in such fossils are held together by the pyrites which closely surrounds them and sharply outlines their contours. The largest cone is 36 mm. long; 32 by 23 mm. in transverse diameter. The best preserved cone is 32 mm. long including a short footstalk, 21 by 19 mm. in transverse diameter. Other cone measurements are: 35 by 30 by 21 mm; 35 by 29 mm. and 35 by 30 mm. (third diameter much crushed); 30 by 27 by 26 mm. Two small encrusted probably immature cones were 29 by 20 mm. and 30 by 20 mm.

**Seeds:** Obscure, perhaps usually shed but they may be exposed on one scale in V.51694 where their persistence, if so, is due to a thin coating of pyrites over scale and seeds. They are inverted, attached at some distance below the margin of the escutcheon and slightly excavated at the hilar end. Several seeds can be seen thus seated on the stalk of the scale. There are four or five in one tier and possibly one of a lower tier. Unfortunately, the film of pyrites which is responsible for their preservation hides the structure of wing, seed body, and testa. It was not possible to measure these seeds as they lay partly hidden between the scales.

**Remarks and affinities.** The association of twigs with *Sequoia*-like habit and cuticle with cones of similar affinity although not organically connected appears to indicate that they are derived from a single species. One twig actually bears young cones, probably of the same type, although much encrusted. The reference of the smaller cones to *S. fordi*, not to *Sequoia coultssiae* is based not only on their larger stouter character but on their mode of attachment to the

twigs. See the cone in Pl. 13, fig. 4, which measures 25 mm. by 22 and 13 mm. In *S. couttsiae* cones are borne either singly or in pairs at the tips of slender twigs covered by scale-like leaves. Few other plants have been found yet, in fact in the pyritized state, only one *Sabal* leaf and one *Abies* cone and a battered cone of the well known species *Sequoia couttsiae* whose foliage and cones are finer and smaller. Large cones of *Sequoia* type have not hitherto been recorded in British deposits. The form, size and character indicate relationship to *Sequoiadendron giganteum* rather than to *Sequoia sempervirens*. *Sequoia couttsiae*, on the contrary, shows marked affinities with *Sequoia sempervirens* in its small cones, mode of arrangement of its seeds and detailed cell structure of seeds and testa (CHANDLER 1964: 104, pl. 2, figs. 12, 13; text-fig. 2). It is common custom at the present time, following BUCHHOLZ, to use the two generic names mentioned above to distinguish the two living species. Yet some botanists consider that they indicate a distinction without a difference (cf., for example, SCHWARZ & WEIDE 1962: 159). In the case of these fossils the use of the name *Sequoiadendron* is certainly a convenient way of emphasizing that their nearest relationship is with the species *Sequoiadendron giganteum* rather than with *Sequoia sempervirens*.

Even allowing that some shrinkage of carbonaceous tissues may have occurred in the cones before they became encrusted with pyrites, the cones from the Hamstead Beds described as *Sequoiadendron fordii* are clearly specifically distinct from *Sequoiadendron giganteum* because of their appreciably smaller size. BUCHHOLZ quotes 50 to 70 mm. as typical lengths while the largest fossil specimens available to the writer are 47 mm. A further distinction lies in the form of the escutcheon which in *S. giganteum* is not so high relative to the breadth as in *S. fordii*. Moreover, its median area is commonly deeply sunk and surrounded by very conspicuous radial ridges alternating with deep furrows. The associated twigs, also referred to *S. fordii*, are more densely clothed with leaves than *S. giganteum* and their leaves are more curved. Pollen of *Sequoiadendron* has been recorded from the London Clay (SEIN 1961) and from the Bembridge and Hamstead Beds (PALLOT 1961). One at least, after some hesitation, stated that in her opinion the sparse grains belonged to *Sequoiadendron* rather than to *Sequoia*. This was disquieting until the discovery of *Sequoiadendron fordii* in view of the strong evidence connecting *Sequoia couttsiae* with *Sequoia sensu stricto*. The bifacial habit of *Sequoia sempervirens* foliage may be regarded as of no particular significance generically for it can crop up in other conifers which do not normally display it (cf. *Cupressistrobus gardneri*).

From the Upper Oligocene of the Paris Basin GRAMBAST (1962: 26, pl. 1, figs. 1, 2, 5, 7, text-fig. 5) describes *Sequoiadendron squamatum* (Brongniart) giving synonyms used in earlier erroneous determinations. The foliage of this species is more scaly than in *S. fordii* with shorter leaves closely applied to the branches. The cones are similar in size (30 mm. long by 35 mm. broad) but the escutcheons of the scales are more transversely elongate relative to their height (3.5 to 4 mm. high, 8 mm. broad). It therefore appears that the Paris Basin species is distinct.

The probable identity of *S. fordii* with barren twigs described as *Araucarites* from the Bournemouth Beds is indicated by the references listed at the head of this description. It is discussed at some length in the Introduction to the Hamstead Beds on pp. 36-38 as a matter of general interest. Briefly, twig form and size and cuticle structure afford grounds for uniting the new Hamstead *Sequoiadendron* and the old Bournemouth *Araucarites* as a single genus and probably the same species. The discovery of the cones associated in abundance with the foliage in the Hamstead Series necessitates the transfer of the Bournemouth *Araucarites* to the genus *Sequoiadendron*. The reasons for the introduction of a new specific name in place of the old names "*goepperti*" and "*sternbergi*" are also explained on p. 36.

## Genus *SEQUOIA* Endlicher

### *Sequoia couttsiae* Heer

(Pl. 10, figs. 4, 5, Pl. 18, fig. 2, Pl. 20)

1962. *Sequoia couttsiae* Heer: Chandler p. 20, pls. 1-3; pl. 4, figs. 1-32; text-figs. 1-6. See also for earlier references.

1964.. *Sequoia couttsiae* Heer: Chandler, p. 104, pl. 2, figs. 12, 13; text-fig. 2.

Among the pyritized debris from the Hamstead Beds there is one cone of *Sequoia couttsiae* (V.51691) which presents a marked contrast to the larger cones of *Sequoiadendron fordii*. Like a few specimens of that species its gaping scales have undergone much disintegration so that the escutcheons are not preserved but the fraying limbs are encased in pyrites mud so that they have retained their characteristic shape and the cone has therefore a typical appearance. About twenty-five spirally arranged scales can be counted excluding the small not readily individualized scales at the base and extreme apex. The axis of the cone (partly hollow) is exposed at the base. Length of cone 19 mm. including short stalk; diameter 14 by 10 mm. Height of largest scales about 3 mm; breadth 4 to 6 mm.



The reasons for referring this species to *Sequoia* and not to *Sequoiadendron* were given by CHANDLER (1964: 104). The pyrites mud which fills the interspaces between the scales shows embedded remains of gastropods and cyprids.

A perfect pyritized cone (V.53031) retaining 4 mm. of stalk bearing remains of a few closely adpressed scale-like leaves was found later (Pl. 18, fig. 2). Length without stalk 19 mm; diameter 18 by 15 mm. About twenty-nine spirally arranged scales can be counted. Escutcheons lozenge-shaped or five-sided with central mucro obscure transverse median ridge and radial wrinkles. The escutcheons are almost as high as broad. They are partly obscured by a film of pyrites. This cone is the most perfect, uncrushed specimen of *Sequoia couttsiae* in existence. The undersides of two ironstone slabs from the base of the Hamstead Beds, Bouldnor, with a number of specimens of *S. couttsiae* are shown on Pl. 20.

### Family ABIETINEAE

#### Genus *PINUS* Linnaeus

##### *Pinus fordii* n.sp.

(Pl. 15, figs. 1, 2; Pl. 19, figs. 3, 4)

**Diagnosis.** Cone markedly slender and attenuated distally with thickened clearly defined escutcheons and stout stalk.

**Holotype.** V.51692. The upper part of the cone only remains preserved.

**Description.** Cone: Markedly elongate and tapering distally. Stalk thick, from which a few basal scales may have been torn. Slightly flattened, perhaps in fossilization, so that the transverse diameters at right angles are not quite equal. Scales spirally arranged in about thirteen tiers. At least sixty-five scales can be counted on one broad surface. Escutcheons where best preserved in the upper half, thick, quadrangular in outline and sharply delimited below from the proximal part of the scale. Almost invariably so abraded that the true surface has gone exposing longitudinal parallel nerves in the tissues. These are seen in the upper half of the escutcheon which may be delimited by a straight or convex line from a smooth more prominent lower part. On one much worn surface of the cone these parallel nerves are a conspicuous feature (Pl. 15, fig. 2). Upper part of escutcheon often rough through exudation of resin globules (Pl. 15, fig. 1). Adherent pyrites on the rough tissues between the exposed nerves produces low rounded ridges between them in places. When the cone is examined from below conspicuous depressions close to the axis are seen to alternate with the scales immediately above (Pl. 15, fig. 2). These must have accommodated the rounded upper surface of seeds on subjacent scales now torn away. Length of complete cone with stalk 112 mm. Length of lower part (found originally) 67 mm. of which 27 mm. are stalk. Maximum diameter of cone 25 by 23 mm. Diameter of stalk (slightly increased by pyrites encrustation) 11 by 6 mm.

**Remarks.** Only the lower half of this cone was originally found (Pl. 15, figs. 1, 2). Its poorly preserved thick stalk and scales with rounded apices suggested an *Abies* with axis exposed below by the shedding of deciduous scales. When some two years later, after this manuscript had been handed in, Mr. FORD found the upper half of the same specimen in approximately the same position on the foreshore it was at once apparent that the resemblance to *Abies* was accidental. The form of the scales with thick escutcheon indicated a species of *Pinus*. The two halves reunited fitted together perfectly and the discovery of the distal end after such a long interval must indicate that little erosion of the submarine clay platform is taking place at present and that there is little transport by wave action at this depth.

The unusually slender, attenuated form distinguish this cone clearly from other species described from the Lower Tertiary Beds of England. It is, therefore, perhaps justifiable to give it the specific name *Pinus fordii* in honour of the finder.

A second much decayed crushed cone with worn escutcheons on one side only may be a somewhat larger specimen of the same species. It was found by Mr. FORD *in situ* 25 yards west of the Defence Boom, Newton River, Isle of Wight.

##### *Pinus* sp.

(Pl. 19, figs. 5, 6)

**Description.** Cone V.53033 ovoid (compressed in fossilization) scales gaping a little below. Base perfect when found but a few basal scales were lost before the specimen was handed in. Scales spirally arranged in about four tiers with a lower one or two tiers now gone. About four scales are seen on one surface in each complete tier. Escutcheons sharply defined,

quadangular, broader than high with central mucro and obscure radial ridges at the margins but whole surface much abraded and partly obscured by pyrites encrustation. Dimensions of escutcheons at middle of cone: 14 by 7 mm; 14 by 8 mm. Length of cone estimated from curvature of sides looking onto least diameter not more than 45 mm. Maximum breadth 27 by 18 mm.

**Remarks.** This specimen was collected nearer to Yarmouth below "The Warren". It is too imperfect and insufficiently distinctive to name but its form and the escutcheons show that it is quite distinct from the long tapering slender cone of *Pinus fordii*.

## ANGIOSPERMAE

### Class MONOCOTYLEDONES

#### Family PALMAE

#### Genus *SABAL* Adanson

#### *Sabal major* (Unger) Heer 1855

(Pl. 15, figs. 7, 8)

1963. *Sabal major* (Unger); Chandler p. 375, pl. 35, fig. 193. See also for earlier references.

**Description.** Leaf: Preserved as a small ironstone nodule reproducing both surfaces with remains of carbonaceous leaf tissue in furrows and crevices. Only the central part of the leaf now exists. The lower surface (Pl. 15, fig. 8) shows the tapering rachis bearing pinnae on both sides. The proximal pinnae on the right are small and reflexed towards the petiole. The leaf appears to have broken at the point where it arises from the petiole which is missing. Remains of about thirteen pinnae are seen on the right while there are only about six on the left of the rachis. They appear to be united at the central part of the leaf but the free distal portions are no longer extant. The midrib is conspicuous on the upper surface of each pinna and the leaf blade between the midribs is concave on this side of the leaf and convex in this position on the lower side. The upper surface (Pl. 15, fig. 7) shows much abraded remains of the ligule on the left preserved as decaying, cracking carbonaceous tissue. Length of leaf fragment from edge of ligule to broken distal end of rachis 56 mm. (64 mm. to broken distal end of longest pinna). Maximum width of specimen (oblique to axis) 72 mm. Maximum width of specimen (oblique to axis) 72 mm. Maximum thickness near base of cast 7 mm. Maximum breadth of rachis on lower surface 24 mm.

**Remarks.** Leaves of similar appearance, varying somewhat in size, are recorded from beds 7 feet above the Black Band (base of Hamstead Series) and from the Middle Hamstead Beds of Hamstead (CHANDLER 1963: 374, pl. 35, fig. 193). They have hitherto been described as *Sabal major* (Unger). It is not clear what constitute the distinctive specific characters of this species but it seems reasonable to suggest that this leaf may belong to the same species as those earlier described from Bembridge and Hamstead horizons.

A smaller fragment with about eight or nine pinnae flanking the rachis on each side has not been figured. Remaining length of rachis 32 mm. Both surfaces well preserved.

## PALMAE

### Genus ?

(Pl. 15, figs. 3-6)

**Description.** Fruit: V.51689. Small, obovoid with a narrow stalk-like basal attenuation. Epicarp not preserved. Exterior of pericarp as exposed rather nodular, formed of stiff, flat, longitudinal fibres which diverge from the stalk and converge towards a point on one side just below the apex. Some of the fibres, seen as impressions of the internal cast, extend throughout the length of the fruit, others taper and disappear at about the middle of the fruit filling interstices between the longer fibres which may branch at acute angles upwards; some of the fibres unite as they pass upwards (Pl. 15, fig. 3). The pericarp described above is no longer carbonaceous but seems to be a mineral replica of the organic tissues. It is so brittle that much of it has broken and disintegrated exposing the white clay cast inside but the basal part, although detached from the cast remains (Pl. 15, figs. 5, 6). Its broken edge, which can be seen in the figures, shows two concentric layers representing the outer and inner surfaces respectively of the fibres. Between the layers the section is



purely crystalline. Seed not seen, if present immersed in the internal clay cast. Length of detached cast 5.5 mm; diameter 4.5 mm. Length of remains of pericarp with its attenuated base 2.5 mm.

**Remarks.** One fruit from the whitey grey clays below Bouldnor cliff at the site described on p. 42. Adhering to the internal cast of the pericarp on one side is a small shrivelled seed of *Rhamnospermum bilobatum* (Pl. 15, fig. 4,V). A fibrous pericarp is common in Palms but presents a different appearance in different genera. Thus in *Chamaerops* the fibres are thin, soft and flexible. In *Serenoa* they are rigid and widely spaced. In *Washingtonia* while rigid also, they are more closely spaced and somewhat nodular. With so little material and that imperfect and without some knowledge of the seed structure, no attempt is made to name this solitary fruit.

## PINNATE PALM

### Genus ?

(Pl. 16, fig. 1; Pl. 17, fig. 1)

1964. Genus ? Chandler p. 129, pl. 4, fig. 31.

The larger counterpart of a pinnate palm leaf fragment of which the smaller counterpart was figured in 1964 is here shown.

It now appears that the ironstone slab which preserved this impression came from the Hamstead Beds, not as was thought previously from the Upper Headon or Osborne Series. The error arose out of a misunderstanding of current local terminology. When Dr. CHESTERS visited the Isle of Wight in company with the finder, Mr. FORD, she was shown the spot where the specimen was actually obtained. It was between two block houses (since blown up) east of Yarmouth, not as was originally thought from the shore between the two large old forts west of the town. To the east the Hamstead Beds form most of the cliffs and foreshore although a limited outcrop of Bembridge Beds is present (see p. 36). It therefore seems highly probable that the specimen was from the Hamstead Series. In any case it is the first pinnate palm leaf to be recorded from the Lower Tertiary Beds of the Isle of Wight.

## Family HYDROCHARITACEAE

### Genus *STRATIOTES* Linnaeus

#### *Stratiotes acuticostatus* Chandler

Synonyms are given by Chandler 1963, p. 374, pl. 35, figs. 187-192

The seeds figured were from the Hamstead Beds of Bouldnor Cliff. It is scarcely necessary therefore to illustrate specimens (V.51817) from a further pocket discovered by Mr. FORD about 100 yards east of his cone bed, in the foreshore below high water mark below Bouldnor Cliff, Yarmouth. Among the seeds in this pocket were numerous immature small specimens as in previous finds.

## Class DICOTYLEDONES

### Family DROSERACEAE

#### Genus *ALDROVANDA* (Monti) L.

#### *Aldrovanda intermedia* Reid & Chandler

(Pl. 16, figs. 2, 3)

1926. *Aldrovanda intermedia* Reid & Chandler: p. 113, pl. 6, figs. 27-29.

1963. *Aldrovanda intermedia* Reid & Chandler: Chandler p. 378, pl. 35, fig. 196.

One seed previously described was from the Hamstead Beds of Hamstead Cliff. Mr. R.L.E. FORD recently found a pocket of typical seeds (V.51820) in the Hamstead Beds of the Bouldnor shore below high water mark about 100 yards east of his bed yielding cones. Two seeds are here illustrated. The neck may vary from about one-tenth to one-seventh of the length of the seed. The inner coat of prismatic cells, usually somewhat broken, is about 0.165 mm. thick. The outer coat is about 0.055 m. thick. The combined thickness of the two occupies approximately one-fifth of the

diameter of the seed. Both coats are very brittle and in consequence some of the seeds are much cracked and broken. The slightly convex ends of the cells of the outer coat are about 0.027 mm. in diameter. Length of seeds about 1.4 to 1.5 mm; breadth about 1 mm.

### INCERTAE SEDIS

#### ? Unidentified Flower

(Pl. 19, figs. 7, 8)

A specimen of unusual appearance, V.53032 coated with pyrites, polished by wave action, bears a superficial resemblance to a flower. While the pyritization is probably responsible for its preservation at all, it certainly conceals any details of cell structure which might have afforded confirmation of its nature. The flower is borne on a stout stalk, which broadens upwards to the broad receptacle some 25 mm. in diameter. It is pressed downwards onto the stalk in such a manner that on one side (described here as the front) more of the flower is shown and on the opposite side (back) more of the stalk itself is seen; on the front a conical ovary is exposed for about 13 mm. It is crushed and shrunken so as to appear irregularly longitudinally ridged. Its apex appears to be truncate (and possibly may be broken). It is surrounded and concealed below by a ring, some five layers deep of innumerable subglobular bodies very suggestive of stamens. These bodies are collapsed and crushed in various directions. The margin of the placenta occupies about one-quarter of the circumference of a circle on this upper side (Pl. 19, fig. 7); on the opposite, lower side of the specimen (Pl. 19, fig. 8) only the tip of the crushed ovary projects beyond the clusters of stamens. A bunch of stamens has been squeezed downwards near the middle of the ring so breaking its continuity accidentally. The upward thickening of the stalk is well displayed as is its clearly defined termination against the placental rim. The stalk is furrowed and ridged, giving it a possibly accidental appearance of bearing bracts tapering upwards. Total length of specimen: 50 mm; maximum breadth, not quite complete on one side, 50 mm; maximum length of stalk on back 30 mm; maximum width across anther ring ca. 10 mm; diameter of crushed anthers 1.5 to 2 mm.

**Remarks.** Further material is badly needed for the satisfactory elucidation of this flower-like object. Meanwhile it is figured and described as so little is known of the Hamstead Flora, in the hope that search may be made for better preserved specimens.

## 4. FEHMARN ISLAND, SCHLESWIG-HOLSTEIN

A few additional specimens from Katharinenhof, Fehmarn Island, were recently loaned by Dr. Ulrich FRANZ of the Schleswig-Holstein Geological Survey. Unfortunately, they quickly showed signs of decay as so commonly happens in pyritized specimens like those of the London Clay. A photographic record was made of the most important material.

### *Wetherellia variabilis* Bowerbank 1840

(Pl. 18, figs. 6-8)

Five large fruits of *Wetherellia variabilis* Bowerbank, in various stages of abrasion and splitting, together with numerous seed-casts now serve to confirm the reference to this species which was tentative only (CHANDLER 1958: 354). Dehiscent cocci show typical narrow flattened pendulous seeds with long arched funicle and ventral raphe (Pl. 18, figs. 6-8). Length of largest coccus 22 mm; breadth 19 mm; thickness across the two valves 11 mm. Seed-cast length 15 mm; breadth 5 mm.

#### NEW RECORDS FOR THIS LOCALITY:

### *Lobaticarpum variabile* Reid & Chandler 1933

(Pl. 18, fig. 9)

A four-loculed, four-lobed species with two much damaged floats and two well preserved ones even to the apertures from which stout hairs are believed to have originally protruded. Length 11 mm. along axis; diameter at right-angles to axis 16.5 by 18 mm.



*Leucopogon quadrilocularis* Reid & Chandler 1933

(Pl. 18, fig. 10)

This fruit is abraded and shows four locule-casts. Dimensions of globular fruit 4 by 4 mm.

*?Sequoia couttsiae* Heer 1862

(Pl. 18, fig. 1)

A much abraded and pyrites encrusted cone, 15 mm. in diameter is also damaged by worm borings. It displays a few of the scale escutcheons which may be as high as they are wide and about 8 to 11 mm. in diameter. Number of scales obscure and their surface abraded. Arrangement probably spirai, certainly not in opposite alternate pairs. Too poorly preserved for certain determination but there is a strong probability that the cone is *Sequoia couttsiae*, a species only recently recorded from the London Clay (CHANDLER 1964: 154, pl. 2, figs. 12, 13). A beautifully preserved cone of *Sequoia couttsiae* newly recovered from the Hamstead Beds below Bouldnor Cliff is shown for comparison. (Pl. 18, fig. 2).

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## PLATE 1

### Undetermined dicotyledonous leaf

- Fig. 1. Impression of lower surface showing base and part of petiole. Apex missing, margin entire. x 1.5
- Fig. 2. Counterpart showing impression of upper surface. Base slightly incomplete. Apex missing. x 1.5.  
Found by J.N. CARRECK in shelly sandstone of the Blackheath Beds of Chislehurst, Kent, in a loose block lying on a hillside in Sundridge Park estate. This must, Mr. CARRECK states, have come from the well-known Rock Pit or an adjacent pit in the same beds. The pit, often mentioned in geological literature, lay very close to the present Elmstead Woods Station. This and the fruit *Natsiatum eocenicum* Chandler (CHANDLER 1961: 110, pl. 11, figs. 24, 25; 1964: 103) are records of plants from a site where they were previously unknown. Photograph and data kindly supplied by J.N. CARRECK. Preserved in Dartford Borough Museum.



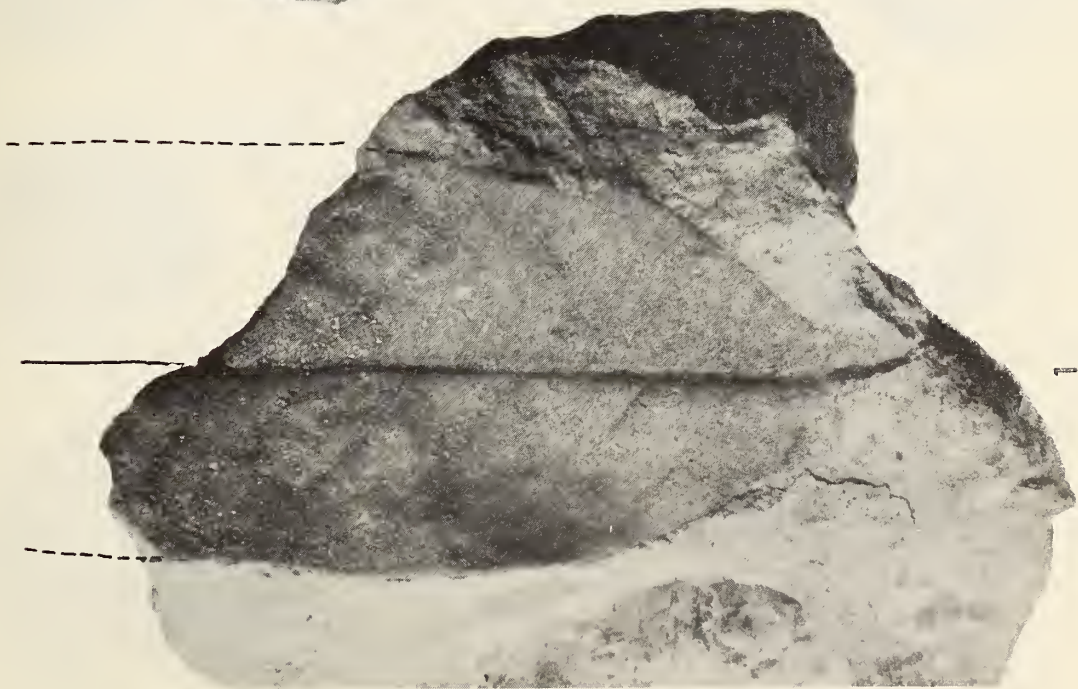
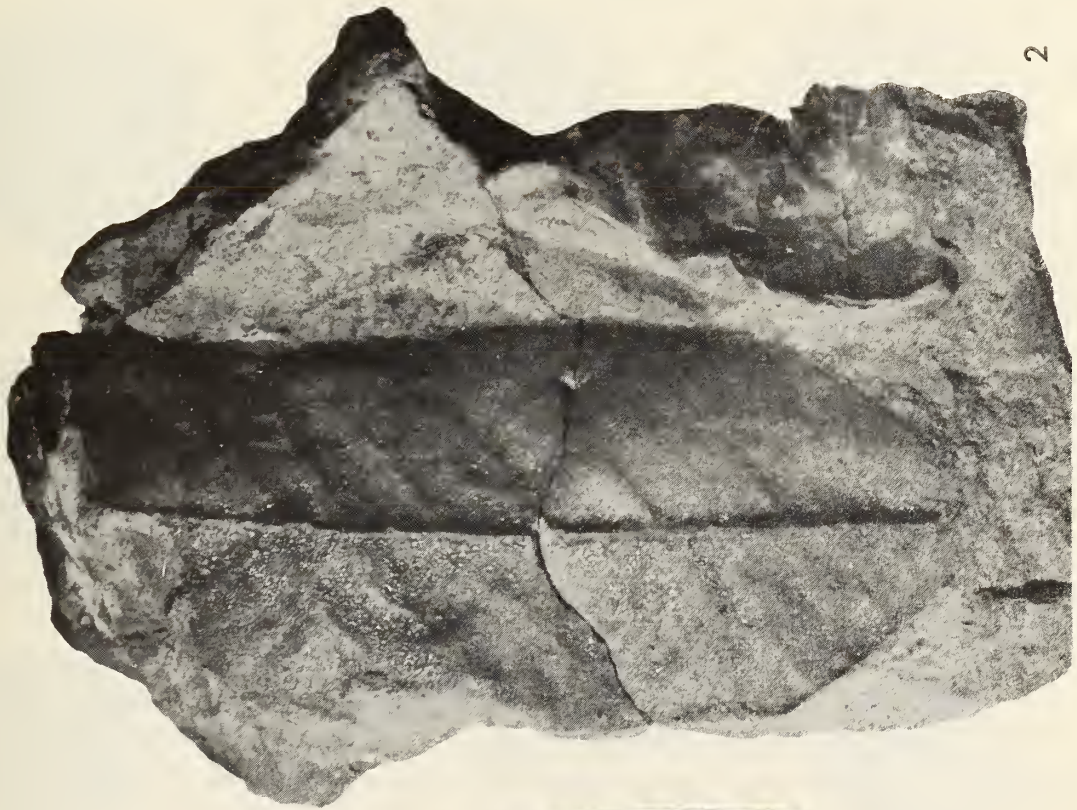


PLATE 1

## PLATE 2

### *Polycarpella caespitosa* Reid & Chandler

- Fig. 1. Capitulum, apex. x 3. (V.51634)
- Fig. 2. Same, side. x 3.
- Fig. 3. Same, base, showing stalk with surrounding furrow occupied by remains of bracts. x 3.
- Fig. 4. Same, longitudinal section showing stalk, *s*, and bases of abraded bracts, *b*, broken off short. The fruits diverge radially from the rounded placenta. Seed and seed casts are exposed along the radii, *sc*. Some dark radial lines are bristles arising at the base of the fruits and forming involucre around them. Narrow straight white radial lines are cut edges of pyrites infillings between adjacent fruits, adjacent bristles, or between fruits and bristles. Some confusion is caused by the overlap of fruits in different planes. Lateral limits of some fruits are indicated by *r*. x 6.5. Sheppey.
- Fig. 5. A larger capitulum, side. x 3. (V.51133)
- Fig. 6. The same, apex. This fruit is somewhat laterally compressed. x 3.  
Conjectural reconstruction of apices of fruit, *f*, and a bract of involucre, *i*, based on *Rhynchospora elatior* Kunth. Warden Point, Sheppey.

### *Corypha wilkinsoni* n.sp.

- Fig. 7. Holotype. Seed cast with hilar-chalazal plug partly preserved. Hilum basal. x 3. (V.51635)
- Fig. 8. Same, opposite side embryo scar just above base indicated by radiating lines around it. x 3.  
Warden Point, Sheppey.

### ? *Trachycarpus* sp.

- Fig. 9. Seed, base, showing attachment, *a*, concavity towards top of figure. x 3. (V.51636)
- Fig. 10. Same, apex, with stylar scar at top of concavity which is at the base of the figure. x 2.
- Fig. 11. Same, side, showing kidney-shaped outline. x 2. Beetle Bed, Bognor.

### *Palmospermum jenkinsi* Reid & Chandler

- Fig. 12. Seed cast looking onto excavation left by removal of hilar-chalazal scar. The white angular patch above is a break in the cast. Hilum at base of figure. x 3. (V.51637)
- Fig. 13. Same, opposite side, showing large embryo-scar near base of figure. x 3. Warden Point, Sheppey.



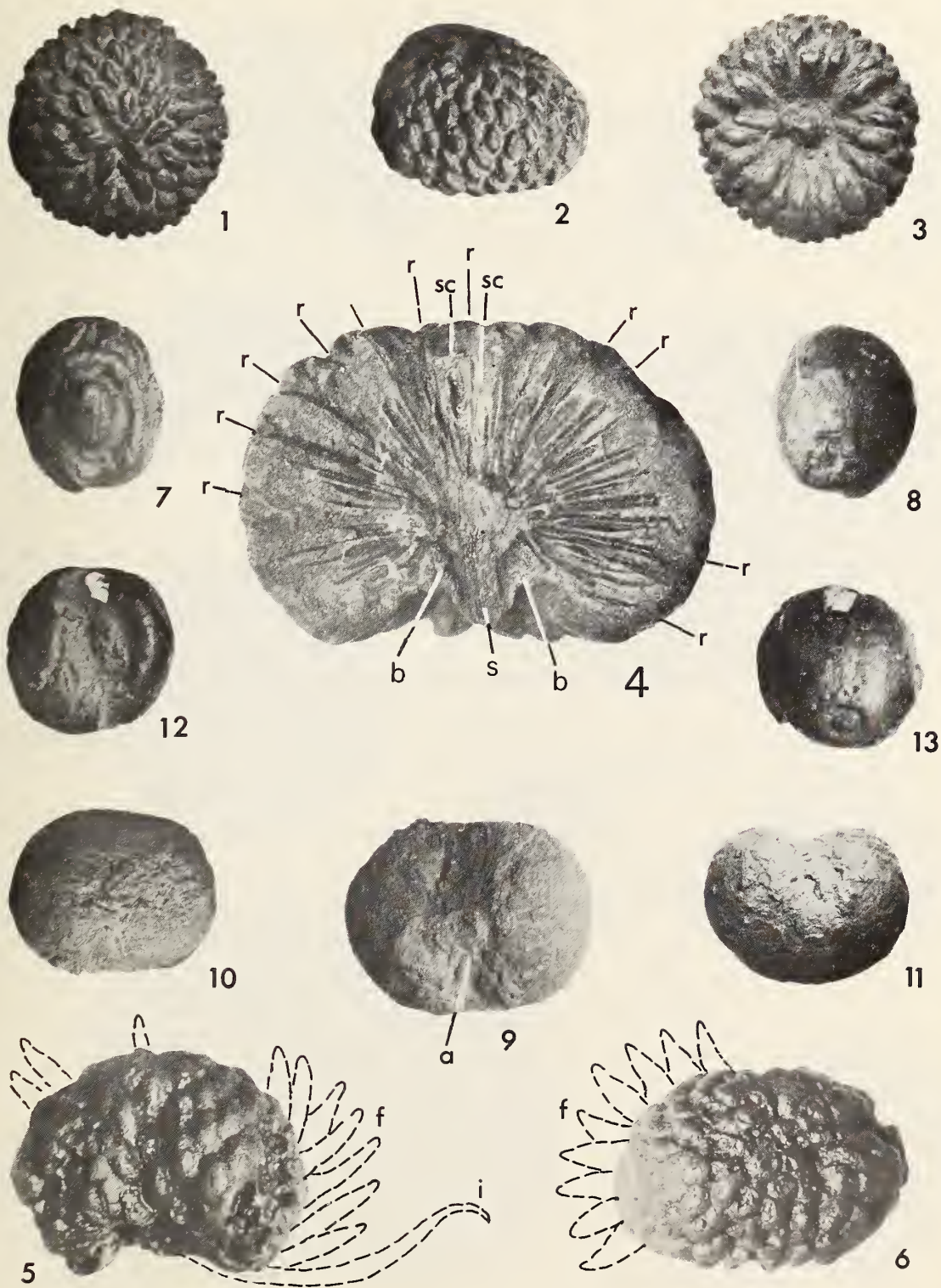


PLATE 2

### PLATE 3

#### *Epipremnum* sp.

- Fig. 1. Curved seed cast with remains of thick spongy testa, **t**; **m**, micropylar limb of cast; **ch**, dark oblique scar of chalaza on inner angle of opposite limb. x 16. (V.51638).
- Fig. 2. Same, opposite side, when less of the testa seen in fig. 1 had flaked away. Cast of tegmen seen against testa. **m**, micropylar limb. x 16.
- Fig. 3. Same as fig. 1, after remains of testa have flaked away. **m**, and **ch**, as above. x 16. Upper Fish Tooth Bed, Bognor.

#### *Pterocaryopsis elliptica* n.sp.

- Fig. 4. Holotype. Fruit, lower surface, showing in the lower two-thirds the outline of the primary lobes of the locule cast. **a**, attachment. x 16. (V.51639)
- Fig. 5. Same, upper surface, with median fibre seen in lower part. x 16. Beetle Bed, Bognor.

#### *Davisicarpum gibbosum* Chandler

- Fig. 6. Side of well preserved endocarp showing gibbous inflated region between limbs of locule (which are complete) due to a convex outgrowth from the wall of the curved marginal locule enclosing one of the lateral cavities, **st** stylar limb. A curved groove on this area indicates incomplete fusion of the two sides of the outgrowth. x 6.5. (V.51128)
- Fig. 7. Same, base, showing wide gap between the two limbs of the locule occupied by the gibbous central area, **st**, as above. x 3 approx.
- Fig. 8. Same, apex, showing narrow ribbon-like locule (horizontal) embracing the inflated lateral gibbositities enclosing cavities. x 6.5. Warden Point, Sheppey.

#### *Eohypserpa parsonsi* Reid & Chandler

- Fig. 9. Endocarp, side, showing the greater relative breadth of the locular area and the narrower breadth of the outgrowths from it over the central area as compared with *Davisicarpum*. Stylar limb right. x 6.5. (V.51151). Sheppey.



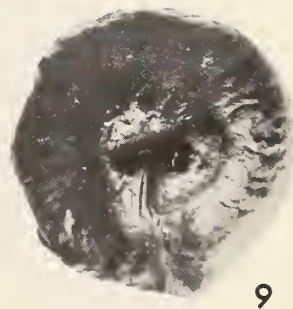
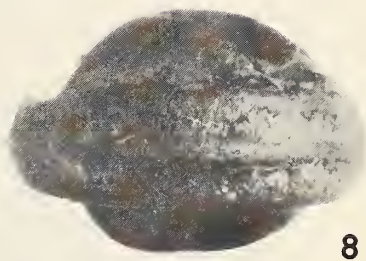
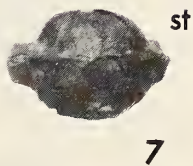
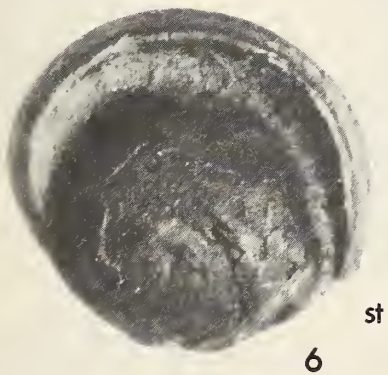
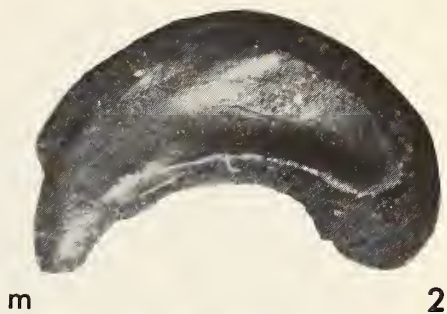
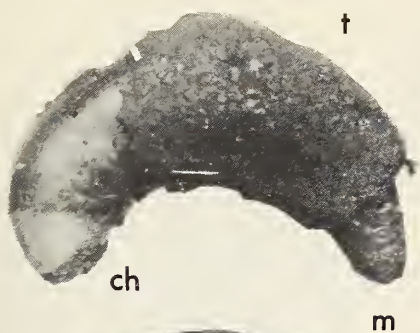


PLATE 3

PLATE 4

*Palaeosinomenium venablesi* Chandler

Fig. 1. Typical obliquely curved small endocarp. x 14. (V.30578a). Beetle Bed, Bognor.

*Wardenia davisii* Chandler

Fig. 2. Endocarp for comparison with the above. x 6.5. (V.51640).

Fig. 3. Very typical but small endocarp. x 6.5. (Decayed). Lower Fish Tooth Bed, Bognor.

*Atriaecarpum venablesi* (Chandler)

Fig. 4. Seed, ventral. *p*, placenta and hilum. Median ridge overlays raphe and chalaza of seed. x 16. (V.51641).

Fig. 5. Same, dorsilateral, showing low median longitudinal ridge and rows of shallow depressions. Ventral edge to right. x 16. Lower Aldwick Beds, Bognor.

*Atriaecarpum deltiforme* n.gen. & sp.

Fig. 6. Holotype. Endocarp, ventral, with cast of ventrilateral hollow ridge preserved on right of median ridge showing truncation due to terminal slit at *o*. Corresponding cast on left broken but with remains of adherent pyrites, *p*. Coarse rugosities of endocarp seen towards base. x 6.5. (V.51642)

Fig. 7. Same, dorsilateral, cast of ventrilateral hollow on left. Tubercles of surface seen below on right of median ridge. x 6.5.

Fig. 8. Same, lateral, ventral surface to left, cast of ventrilateral hollow at *vh*. x 6.5. Warden Point, Sheppey.

Fig. 9. Another endocarp, ventral. Both ventrilateral hollows broken. A growth of pyrites, *p*, adherent around their bases. x 3. (V.51643)

Fig. 10. Same, dorsal, showing rugosities of endocarp flanking median ridge. Pyrites growths, *p*, are seen projecting from the ventral side. x 3. Warden Point, Sheppey.



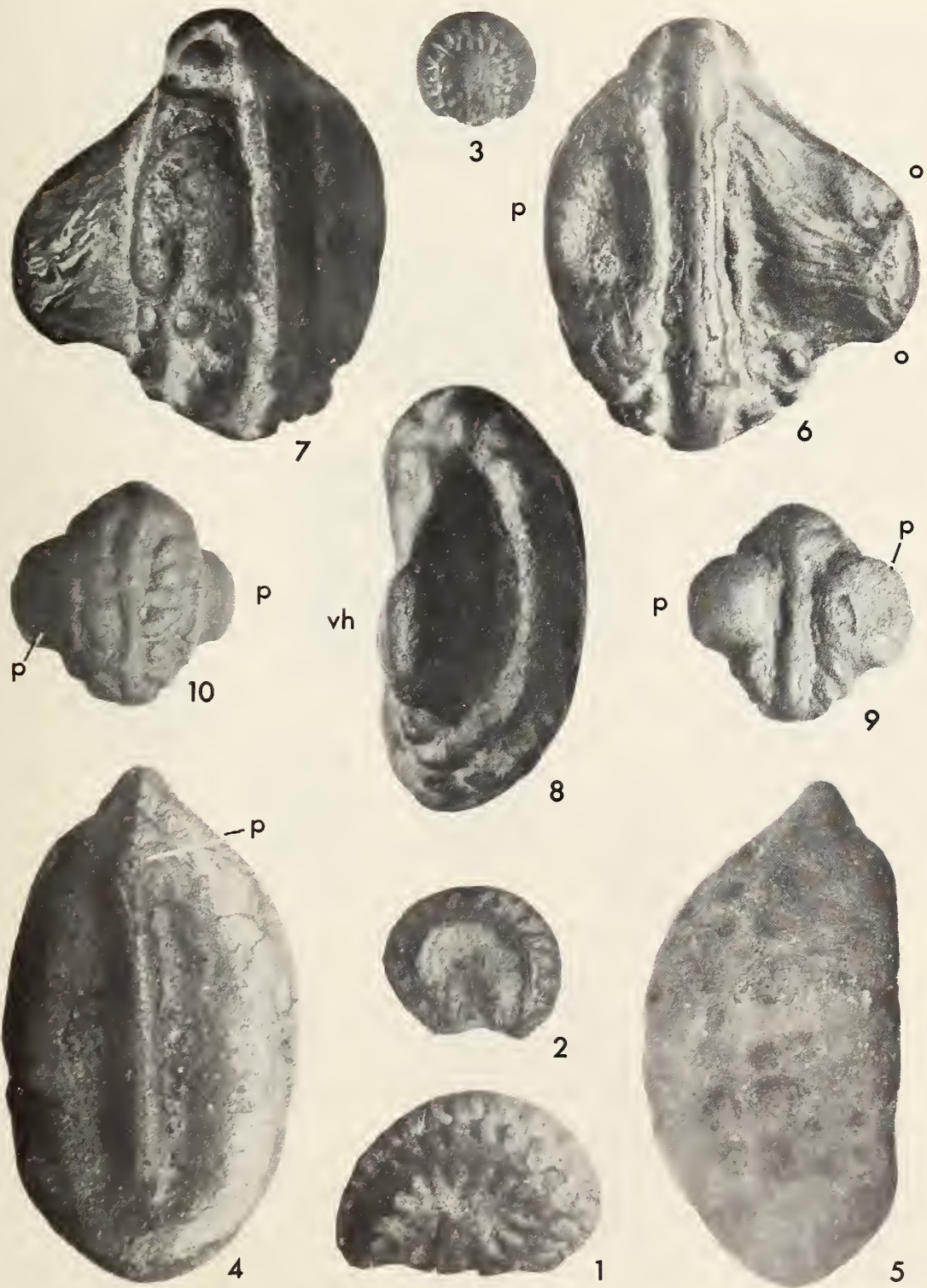


PLATE 4

## PLATE 5

### *Uvaria ovale* (Reid & Chandler)

- Fig. 1. Fruit, placenta side abraded so that two alternating rows of seeds are partly exposed flanking central line of the placentas. x 2 approx. (V.51645)
- Fig. 2. Same, opposite side of worn pod to placentas. Seeds also are so abraded that internal casts representing albumen are exposed. x 3 approx.
- Fig. 3. Upper end of same viewed after turning it to the right through 90° in which position one row only of seeds is visible. x 3 approx.
- Fig. 4. Same, from base. Pairs of seed casts show abraded (hollow) ridges of the albumen. x 3 approx. Beetle Bed, Bognor.

### Capparidaceae Genus ?

- Fig. 5. Seed cast, side, showing closely adpressed limbs of the curved seed. Micropylar limb on left. x 16. (V.51646)
- Fig. 6. Same, opposite side, micropylar limb on right partly concealed by an adherent patch of testa, t, between the limbs. x 16. Beetle Bed, Bognor.

### Family ? (Burseraceae ?) Genus ?

- Fig. 7. Endocarp, ventral, showing transverse median opening and ridges diverging towards the extremities. x 6.5. (V.51647)
- Fig. 8. Same, dorsal, tilted slightly towards the right. x 6.5.
- Fig. 9. Same, lateral, ventral side to right, transverse opening at o. x 6.5. Warden Point, Sheppey.

### *Spondiaecarpon operculatum* Chandler

- Fig. 10. Subglobular form of a two-loculed endocarp; locules right and left; apical valves at v. x 3.3. (V.51648). Warden Point, Sheppey.

### *Sapindospermum taylori* n.sp.

- Fig. 11. Holotype. Seed cast, ventral view, looking onto radicle. x 6.5. (V.51649).
- Fig. 12. Same, radicle left and embracing base. Junction of radicle and inner cotyledon masked by remains of testa. Junction of outer and inner cotyledons and recurved fold of inner cotyledon seen near apex; ch, position of chalaza and reflexed outer end of inner cotyledon (cf. text-fig. 5). x 6.5.
- Fig. 13. Same, opposite side, radicle on right, ch, as above. x 6.5. Upper Fish Tooth Bed, Bognor.

### *Iodes corniculata* Reid & Chandler

- Fig. 14. Carbonaceous endocarp showing elongate form with external pattern only slightly rounded by abrasion. Funicle on right. Horn-like projection overlying placenta subapical on right. x 6.5. (V.51158). (N.B. Most of the carbonaceous carpel wall has now flaked away). Warden Point, Sheppey.

### *Icecinicarya platycarpa* Reid & Chandler

- Fig. 15. Carbonaceous endocarp very slightly smoothed and polished by abrasion. Funicle on right. x 2.2. (V.51161). Warden Point, Sheppey.



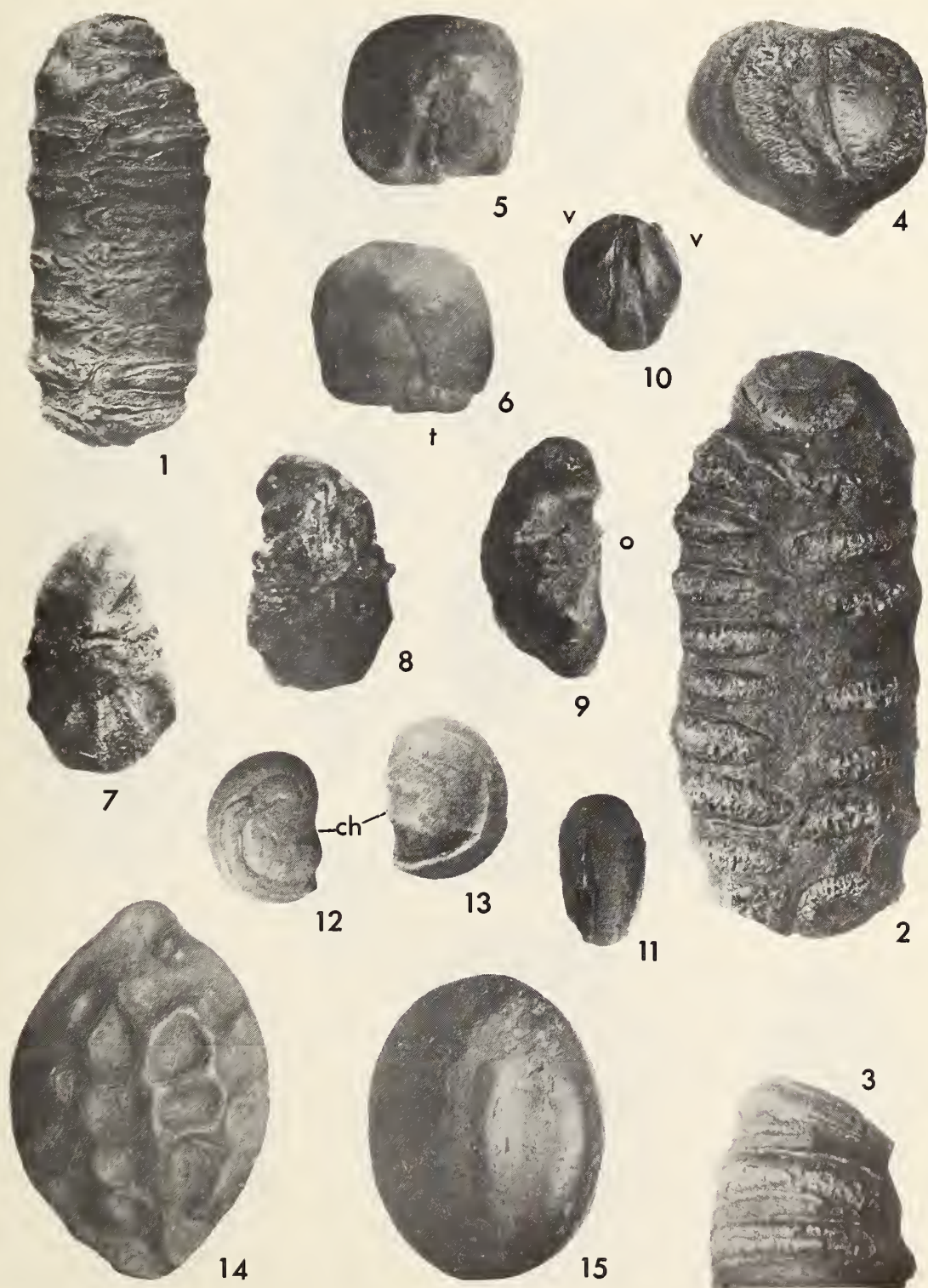


PLATE 5

PLATE 6

*Vitis* sp. (?*Vitis arnensis* Chandler)

Fig. 1. Seed, dorsal. x 6.5. (V.51111)

Fig. 2. Same, ventral. x 6.5. Warden Point, Sheppey.

*Vitis bilobata* Chandler

Fig. 3. Seed, dorsal, with much of the testa preserved, extreme base broken below. x 6.5. (V.51088)

Fig. 4. Same, ventral. x 6.5. Upper Fish Tooth Bed, Bognor.

*Vitis magnisperma* Chandler

Fig. 5. Seed, dorsal, with testa. x 6.5. (V.51080)

Fig. 6. Same, ventral. x 6.5. Upper Fish Tooth Bed, Bognor.

*Vitis* sp. (?*Vitis excavata* Chandler)

Fig. 7. Seed, dorsal, showing narrow chalaza. x 6.5. (V.51112)

Fig. 8. Same, ventral, with deep concavity in place of an infold on right and pyrites cast on left showing that the concavity was originally covered by testa. x 6.5. Warden Point, Sheppey.

*Vitis rectisulcata* Chandler

Fig. 9. Perfect seed tilted forward slightly so that the length below the chalaza is not fully seen. x 6.5. (V.51132)

Fig. 10. Same, ventral. x 6.5. Base of Oldhaven Beds. Upnor, Kent.

*Vitis* sp.

Fig. 11. Much encrusted seed, dorsal. x 6.5. (V.51114)

Fig. 12. Same, ventral. x 6.5. Upper Fish Tooth Bed, Bognor.

*Ampelopsis crenulata* Reid & Chandler

Fig. 13. Seed with testa, dorsal. x 6.5. (V.51075)

Fig. 14. Same, ventral. x 6.5. Lower Aldwick Beds, Bognor.

Fig. 15. A shorter broader seed with testa even less abraded. x 6.5. (V.51076)

Fig. 16. Same, ventral. x 6.5. Beetle Bed, Bognor.

*Tetrastigma sheppeyensis* Chandler

Fig. 17. Typical large seed, dorsal. x 6.5. (V.51092)

Fig. 18. Same, ventral. x 6.5, Lower Fish Tooth Bed, Bognor.

Fig. 19. Smaller seed, scarcely excavated at apex. x 6.5. (V.51093)

Fig. 20. Same, ventral. x 6.5. Upper Fish Tooth Bed, Bognor.



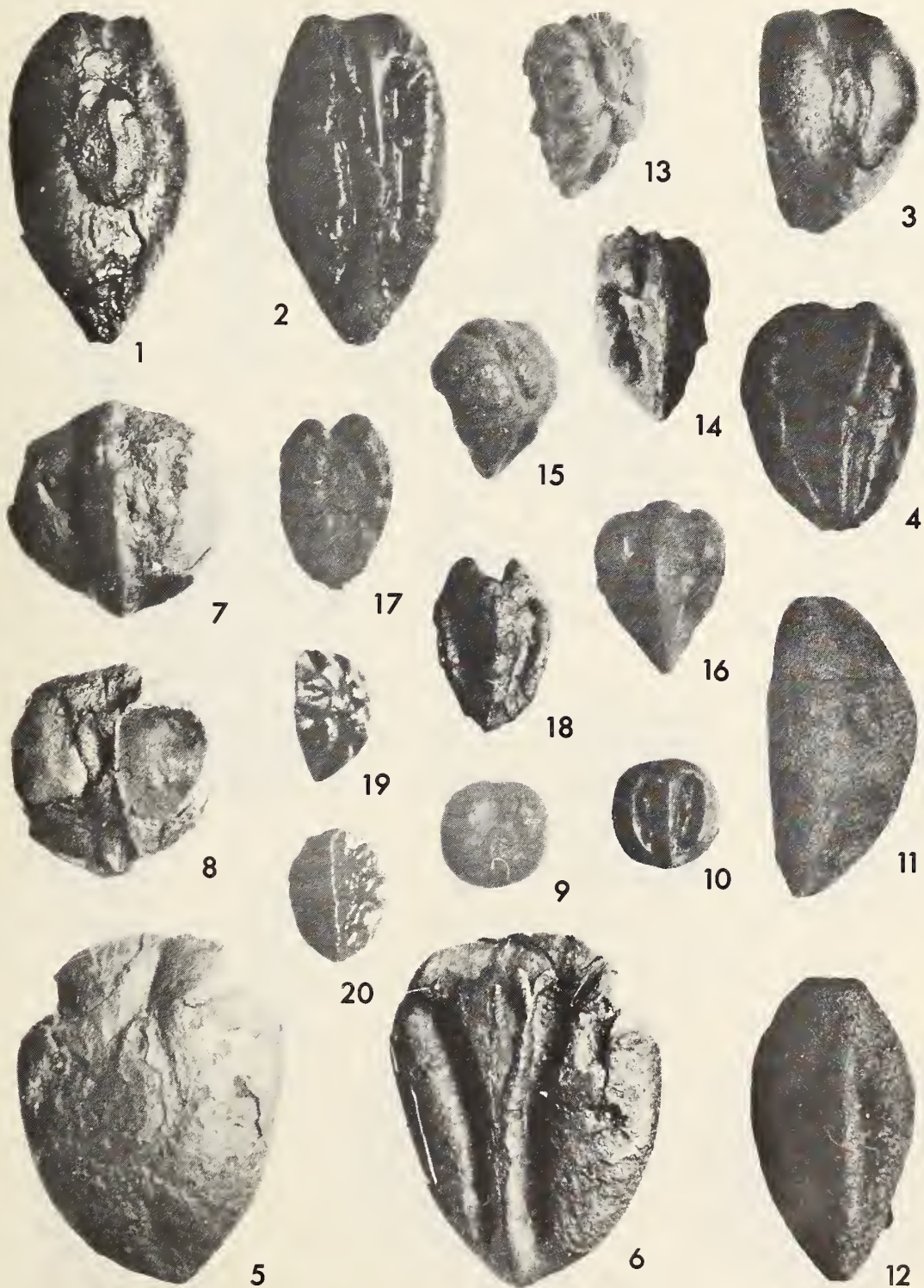


PLATE 6

## PLATE 7

### *Ceriops cantiensis* n.sp.

- Fig. 1. Syntype. Enlarged hypocotyl with plumule, p. Broken at opposite end. x 2.7. (V.51650)
- Fig. 2. Syntype. Another, opposite extremity to plumule showing pointed end and ridged and angled surface. x 2.8 (V.51651)
- Fig. 3. Part of same to show finely wrinkled surface. x 6.5.
- Fig. 4. Another, pointed distal end with corrugated surface. x 2.8. (V.51652).
- Fig. 5. Part of same, to show corrugations. x 6.5.
- Fig. 6. Typical fragment, incomplete at each end, clearly part of a long hypocotyl. x 2.8. (V.51653)
- Fig. 7. Same, to show globular subcutaneous cells. x 16.
- Fig. 8. Much corroded fragment, imperfect at both ends. x 2.8. (V.51654)
- Fig. 9. Beaded cells of interior on a fragment broken from another specimen. x 16. (V.51655). Warden Point, Sheppey.

### *Hightea elliptica* Bowerbank

- Fig. 10. Perfect specimen with exocarp preserved, stylar scar, s, clearly shown, base perfect. x 3. (V.51657). Warden Point, Sheppey.

### Compositae ? Genus ?

- Fig. 11. Achene, side. Pappus ring at apex slightly imperfect on right. x 16. (V.51658)
- Fig. 12. Same, turned to left through 90° slightly tilted to show circular rim of basal attachment scar. x 16. Beetle Bed, Bognor.

### *Carpolithus pusillus* (Reid & Chandler) var. *latus* Chandler

- Fig. 13. Fruit, side, attachment scar with smooth prominent surrounding region on right at a. x 16. (V.51659)
- Fig. 14. Same, ventral, showing smooth prominent, central region with small sunk stalk. It merges into the surrounding rippled part of the integument. x 16. Beetle Bed, Bognor.



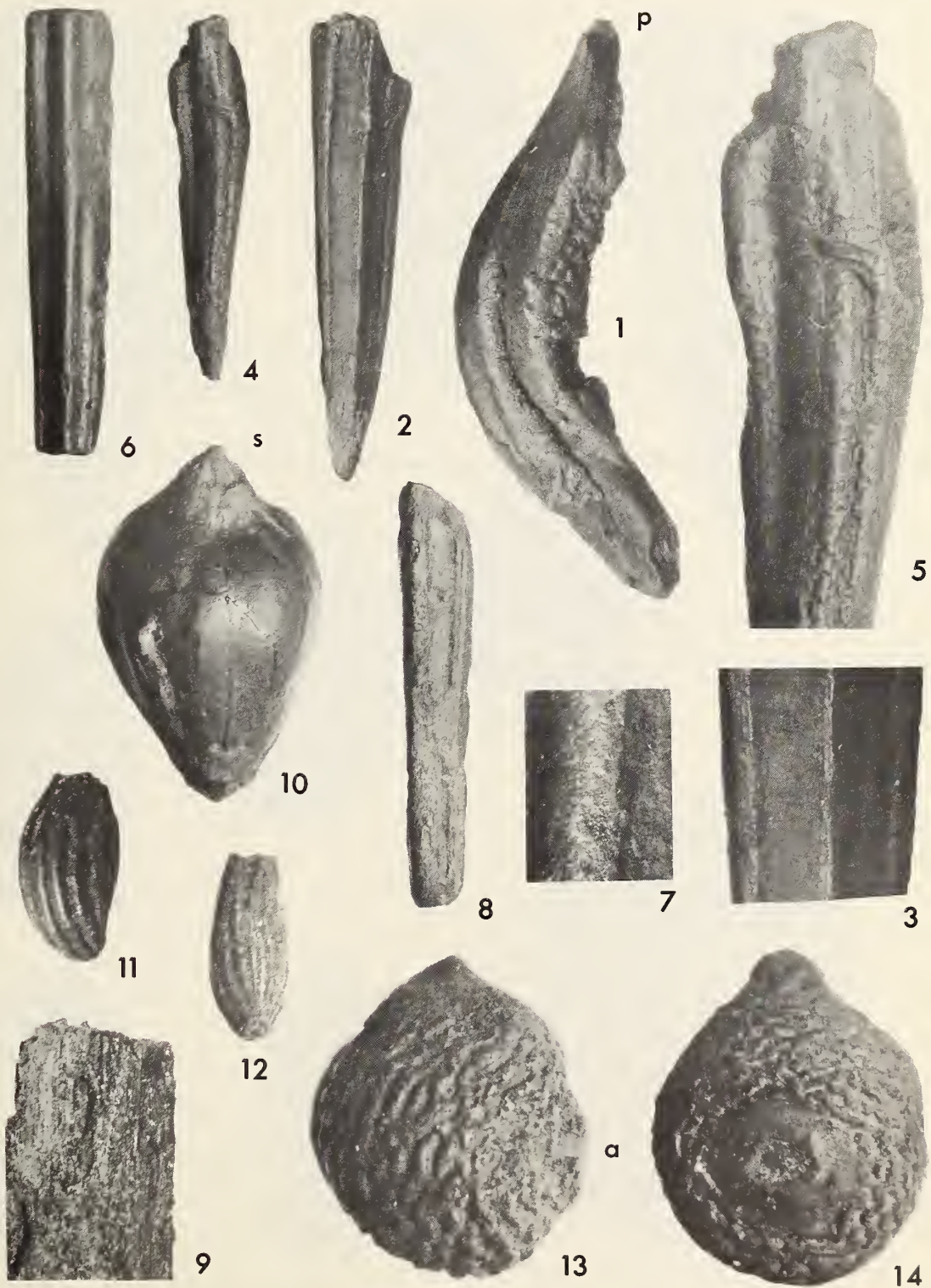


PLATE 7

PLATE 8

*Carpolithus* sp.

- Fig. 1. Fruit with contorted fibres or cell arrangement and dorsal bract projecting around the sides. x 16. (V.51662)
- Fig. 2. Same, opposite surface showing the bract, the fruit tip projects at the apical emargination. x 16. Beetle Bed, Bognor.

*Carpolithus bellispermus* n.sp.

- Fig. 3. Holotype. Tubercled seed with obliquely truncate attachment area; m, micropyle. x 16. (V.51663)
- Fig. 4. Another, with remains of attachment at truncate end (top of figure) micropyle broken. x 16. (V.51664)
- Fig. 5. Another, m, micropyle. x 16. (V.51665)
- Fig. 6. Another, m, micropyle. Some of the tubercled cells are abraded near the base of the figure. x 16. (Decayed). Beetle Bed, Bognor.

*Carpolithus* spp.

- Fig. 7. Tubercled achene. s, style? x 16. (V.51667) Upper Fish Tooth Bed, Bognor.
- Fig. 8. Same, opposite side with median fibre band and short furrow on radicle. x 16. Lower Fish Tooth Bed, Bognor.
- Fig. 9. Seed cast showing furrow indicating septum? or two cotyledons side by side. r, radicle. Attachment in emargination at base. x 16. (V.51668)



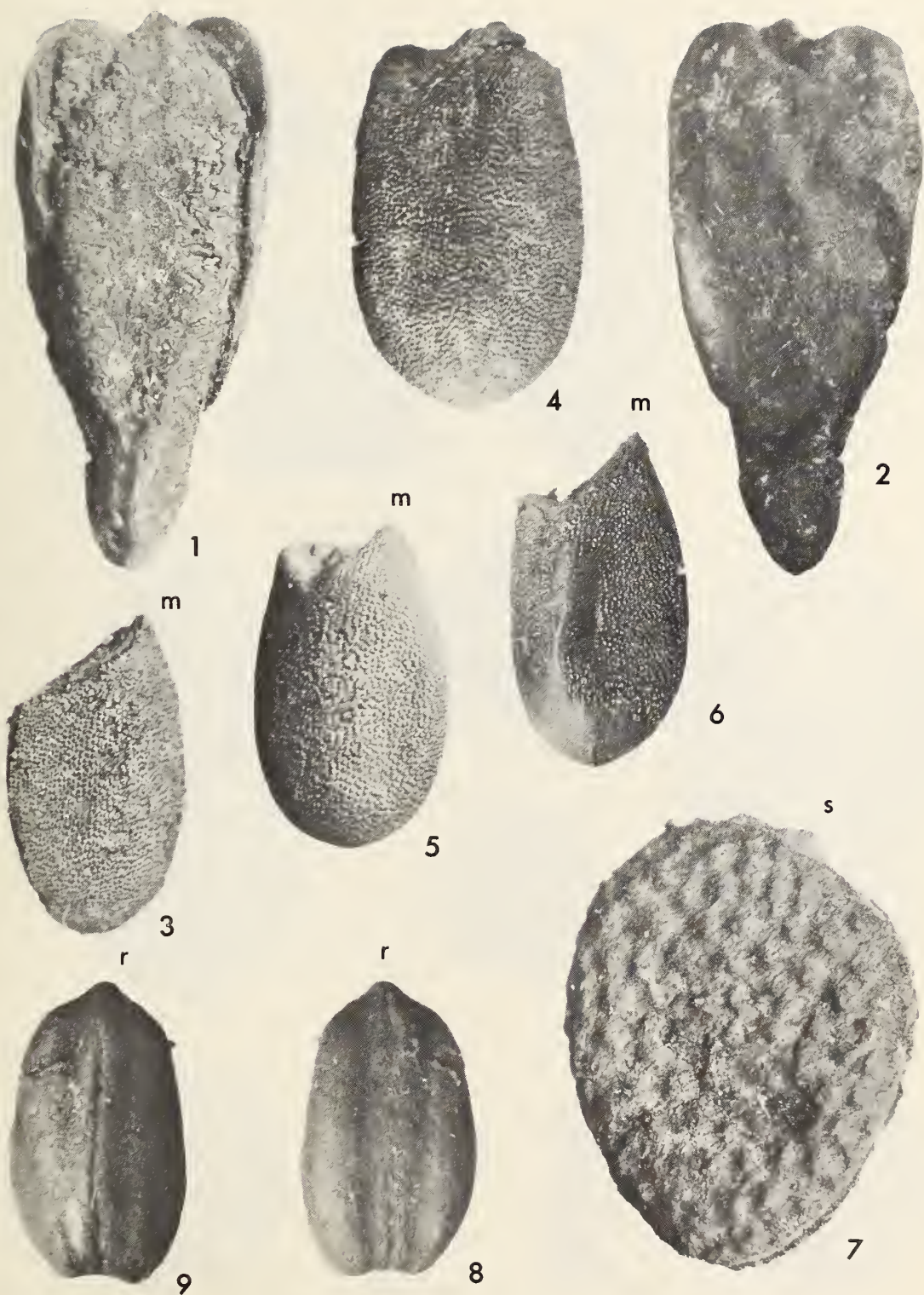


PLATE 8

## PLATE 9

### *Carpolithus anthozoiformis* Chandler

- Fig. 1. Side, superior fruit exposed in upper half through removal by abrasion of the ribbed calyx or involucre. x 16. (V.51669)
- Fig. 2. Same, apex showing angled fruit with layer of coarse radial cells surrounding it and exposed in broken involucre below. x 16.
- Fig. 3. Immature fruit or bud of the same species. x 16. (V.51670). Lower Aldwick Beds, Bognor.

### Tuber or Swollen Root

- Fig. 4. Exterior with central fibre. x 2.5. (V.51671).
- Fig. 5. Same, longitudinally fractured surface with fibrous core. x 2.5 Lower Fish Tooth Bed, Bognor.

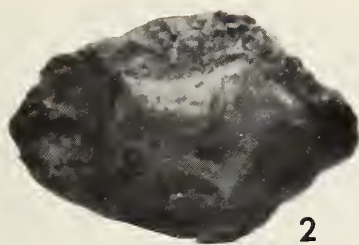
### Tap Roots

- Fig. 6. Side view of swollen root cut artificially below (never seen in perfect condition). Scars of foliage around abraded upper end. x 1.3 approx. (V.51672)
- Fig. 7. Same, upper end with leaf scars surrounding core of root. x 1.2 approx.
- Fig. 8. Cut end of same showing concentric and radial cracks filled with pyrites around the core (black) of parenchyma. Sides of root, in shadow, in perspective also appear black. x 1.3 approx.
- Fig. 9. Side view of another smaller tap root, upper end. Lower and middle part had been cut away. Part of surface above removed by an oblique cut in fossilization. x 1.2 approx. (V.51673)
- Fig. 10. Same, upper end with leaf scar. The obliquely broken surface is below in the figure. x 1.2 approx.
- Fig. 11. Same, cut lower surface showing more clearly than previous specimen the concentric and radial cracks filled with light coloured pyrites. x 1.3 approx. Sheppey.

### Branched Spines

- Fig. 12. Spine bearing four branches all much encrusted with pyrites. x 6.5. (V.51674)
- Fig. 13. Another with three branches even more encrusted. x 6.5. (V.51675). Beetle Bed, Bognor.





2



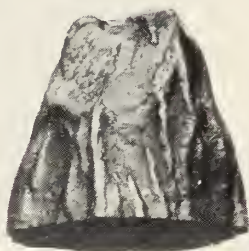
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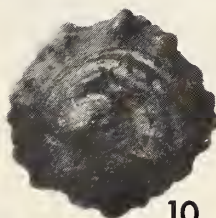
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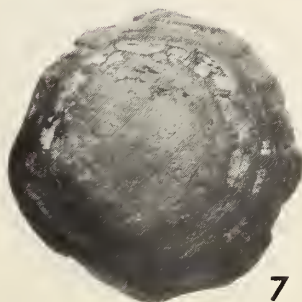
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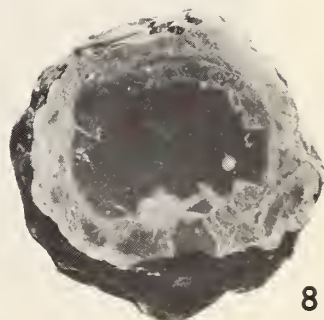
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12



13



8

## PLATE 10

### Unidentified Dicotyledonous Twig

- Figs. 1, 2. Two views at 90° to one another of the somewhat flattened twig showing grooved ridges alternating with furrows on the surface stripped of its external layers. It simulates a cast of the cortical tissues of *Equisetum*. An accidental constriction simulates a node but in fig. 1 the ridges are seen to pass directly across it, whereas in an *Equisetum* node they would alternate on the two sides of it. x 3 approx. (V.51677)
- Fig. 3. End of the above showing a radial segment of the transverse section. The medullary rays which project at the surface are formed of small rectangular cells; they alternate with rays of xylem showing coarse vessels surrounded by parenchyma. The edges of the xylem form the surface furrows. x 16. London Clay, Sheppey.

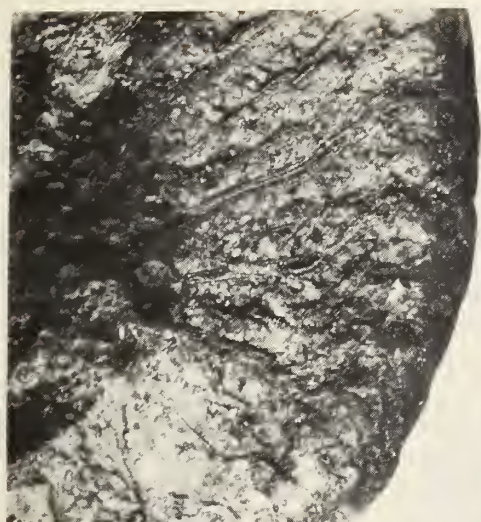
### *Sequoia couttsiae* Heer

- Fig. 4. Cone preserved by infiltration and solidification of pyrites between the decayed gaping scales (now much disintegrated). Footstalk seen at base. Scales appear dark in figure. For comparison with one of the smaller cones of *Sequoiadendron fordii* n.sp. in figs. 6-10 at the same magnification. x 1.6. (V.51691)
- Fig. 5. Same, opposite side where scales are more disintegrated. The pyrites which surrounds the dark scales appears light in colour. x 3 approx. Base of Hamstead Beds, on shore below Bouldnor Cliff, Yarmouth, Isle of Wight.

### *Sequoiadendron fordii* n.sp.

- Fig. 6. Syntype. Small perfect cone with short footstalk and gaping scales. x 1.6 (V.51694, now decayed)
- Fig. 7. Same, opposite side. x 1.6.
- Fig. 8. Same, turned to left through 90°. x 1.6.
- Fig. 9. Same, opposite side. x 1.6.
- Fig. 10. Same, apex, side shown in fig. 7 is to left. x 1.6.
- Fig. 11. Syntype. Typical large cone with remains of footstalk. Convex surfaces of scales due to encrustation with pyrites. x 1.6. (V.51701). Base of Hamstead Beds, on shore below Bouldnor Cliff, Yarmouth, Isle of Wight.

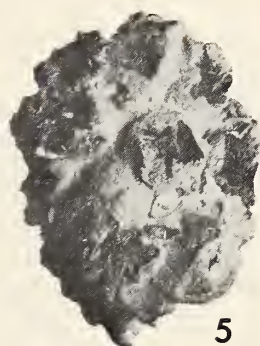




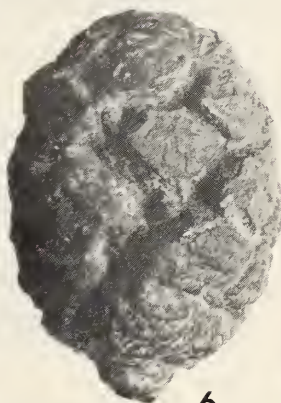
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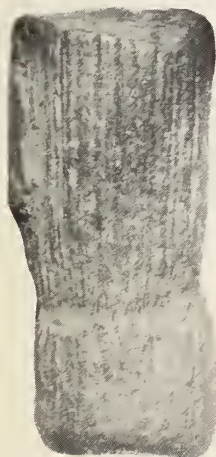
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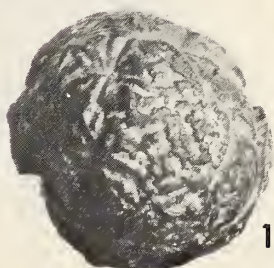
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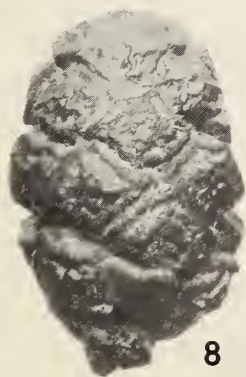
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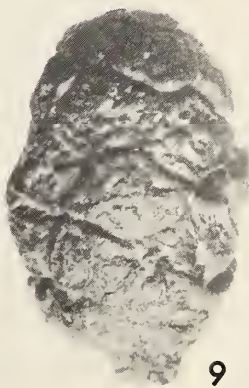
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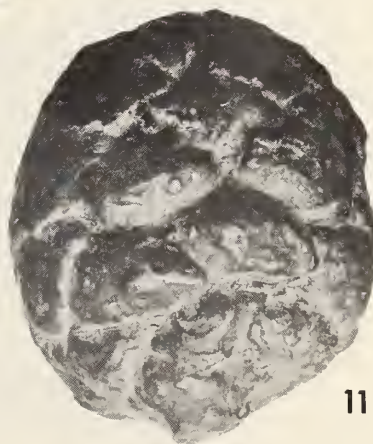
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8



9



11

PLATE 11

*Sequoiadendron fordii* n.sp.

- Figs. 1, 2. Counterpart halves of a cone which has been broken transversely. Fig. 1 is the cut surface of the upper half. s, indicates a saw cut preliminary to fracture. The sections show the axis and four scales with pyrites infilling between them. x 1.7. (V.51699, now decayed).
- Figs. 3-5. Syntype. Fig. 5 shows the opposite side to figs. 3 and 4. The large cone is attached by a footstalk to a small twig fragment (right in figs 3, 4) showing bases of decurrent leaves. Some scales are obscured by pyrites. In fig. 5, a small imbricate twig with scale-like leaves adheres to the cone to the right of the centre. Fig. 3 x 0.9. Figs. 4, 5 x 2 approx. (V.51697, now decayed)
- Figs. 6-9. Four more cones. Figs 7 and 9 are much encrusted. Fig. 8 is attached to a twig (left). Its scales have rotted and burst showing decaying tissues and resin within held together by the adherent pyrites. Figs. 6, 8 x 0.9. Figs. 7, 9 x 1.4. Fig. 6 (V.51700), fig. 7 (V.51678), fig. 8 (V.51698, now decayed), fig. 9 (V.51695). Base of Hamstead Beds, on shore below Bouldnor Cliff, Yarmouth, Isle of Wight.



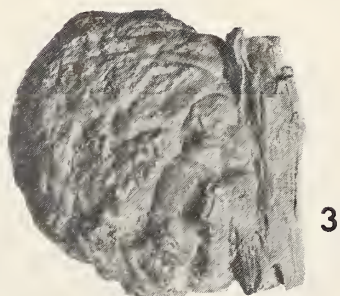
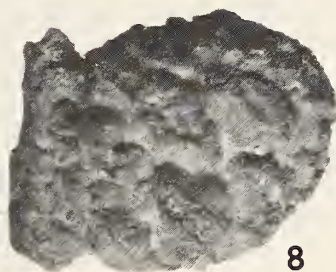
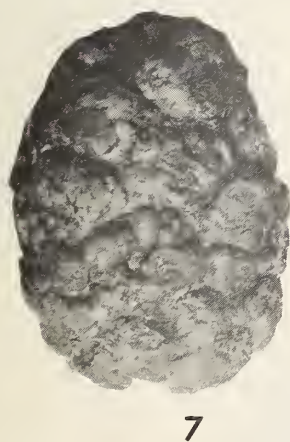
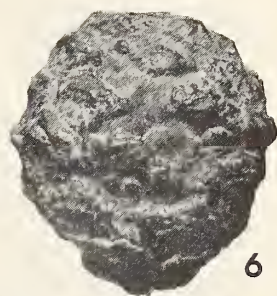
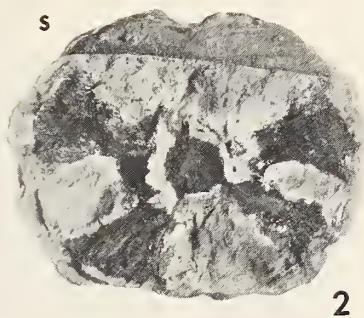


PLATE 11

PLATE 12

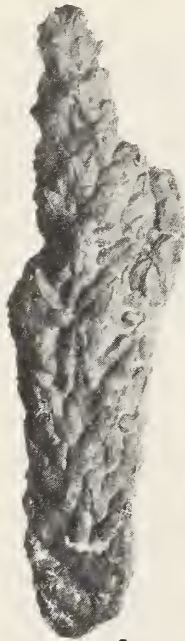
*Sequoiadendron fordii* n.sp.

- Fig. 1. Twig with dense covering of long falcate leaves all much encrusted. x 1.2. (V.51679).
- Fig. 2. Syntype. Another from which fragments of cuticle (cf. Pl. 13, fig. 5) were obtained. Broken branch obvious at base on left. x 1.2. (V.51680).
- Figs. 3, 4. Syntype. Another twig, broken at the tip, with leaf tips well preserved and two immature cones at c. All much pyrites encrusted. The two figures show opposite surfaces. x 1.2 (V.51696). Base of Hamstead Beds, on shore below Bouldnor Cliff, Yarmouth, Isle of Wight.
- Fig. 5. Barren foliage, probably this species, now much decayed and held together by size (glue), described as *Araucarites goepperti* or *A. sternbergi* (see p. Part of twig figured by GARDNER 1883, pl. 12, fig. 2. x 1.3 (V.15115).
- Fig. 6. Another similar twig fragment; x 1.9. (V.46009). Both Bournemouth, GARDNER Collection.
- Fig. 7. Carbonaceous twig densely clothed with long falcate leaves, bearing remains of three immature cones, c, all embedded in clay matrix. To left at i are short lengths of small imbricate twigs with scale-like leaves. x 1.5. (V.51681). Old collection, believed to have come from the Hamstead Beds, Isle of Wight.





5



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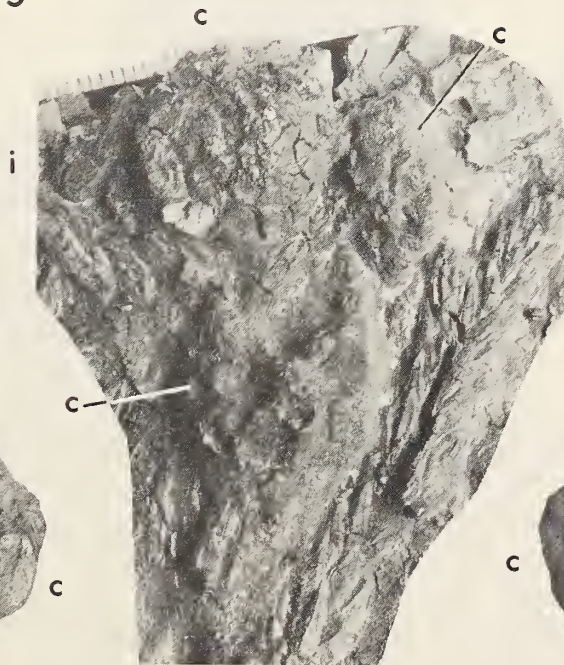
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PLATE 13

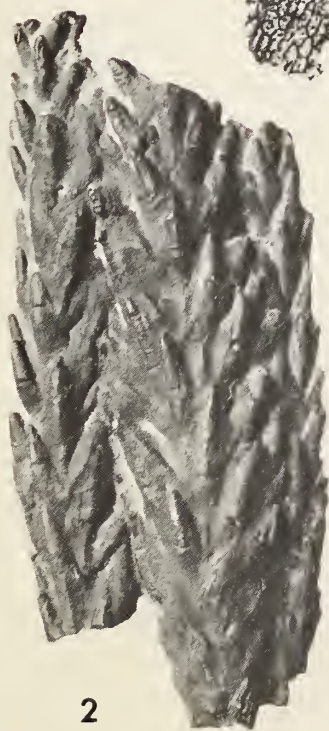
*Sequoiadendron fordii* n.sp.

- Fig. 1. Proximal part of V.51681 in Pl. 12, fig. 7, to show in greater detail the long falcate leaves. x 6.5. Old collection, thought to come from Hamstead Beds, Isle of Wight.
- Fig. 2. Group of three pyrites-encrusted twigs cemented together. Encrustation somewhat obscures the curvature of leaves but it is seen on right of median twig. x 2. Base of Hamstead Beds, on shore below Bouldnor Cliff, Yarmouth, Isle of Wight. Mr. FORD's private collection.
- Fig. 3. Variable barren foliage, probably this species, impressed in sandy matrix. Part of twig figured GARDNER 1884, pl. 11, fig. 1 and SEWARD 1919: 268, fig. 74A. (*Araucarites goepperti* of GARDNER, *A. sternbergi* of CHANDLER). x 1.3. (V.15114). Bournemouth.
- Fig. 4. Small immature cone attached to side of twig, hence readily distinguished from *Sequoia couttsiae* in which cones are borne on ends of twigs. x 1.6. Mr. FORD's private collection.
- Fig. 5. Fragment of upper cuticle from twig in Pl. 12, fig. 2, s, stomatal band to left of line between m-m, the median band of ordinary epidermal cells; st, edge of right stomatal band. Four slightly oblique stomata contiguous and aligned in a row (left) are preserved. The median epidermal cells are equiaxial at me, elongate and pointed at e. x 100 approx. (V.51680a). Base of Hamstead Beds, on shore below Bouldnor Cliff, Yarmouth, Isle of Wight.

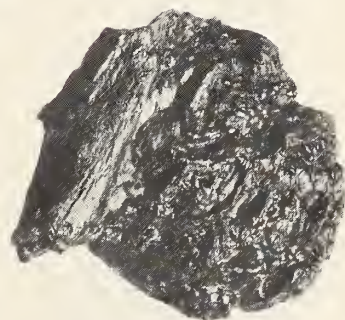




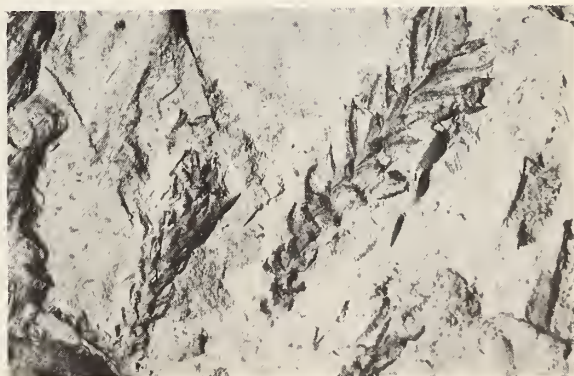
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PLATE 13

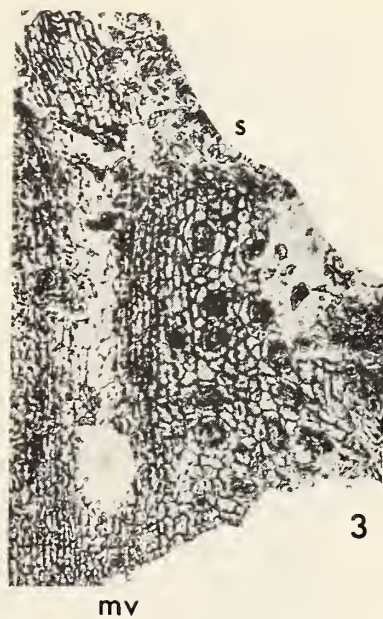
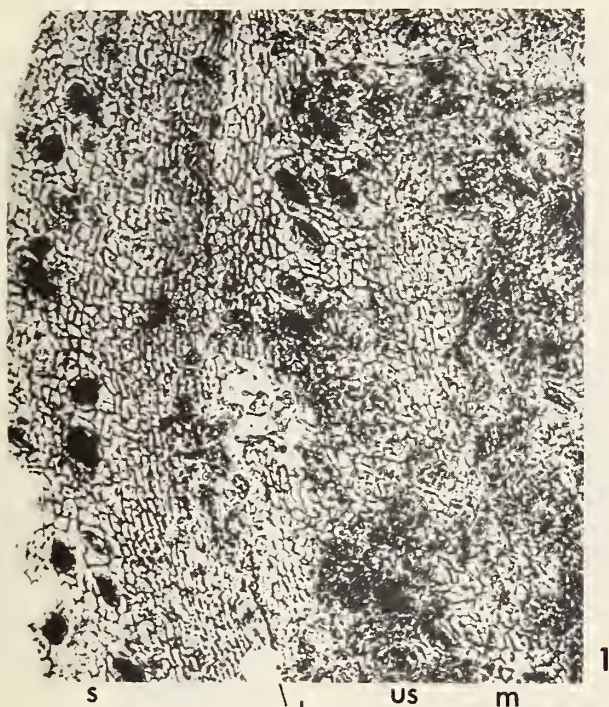
## PLATE 14

### *Sequoiadendron fordii* n.sp.

- Figs. 1-4. Show cuticle fragments (V.51680a) from twig in Pl. 12, fig. 2. All x 100 approx. Base of Hamstead Beds, shore below Bouldnor Cliff, Yarmouth, Isle of Wight.
- Figs. 1, 2 Closely adjacent fragments from same leaf which separated in the position between the two figures. Fig. 2 is slightly displaced to the left in mounting in relation to fig. 1. Fig. 2 is the more proximal fragment of the two. *l*, lateral angle of the leaf with the denser lower cuticle to the left of it. The cells of the ordinary epidermal marginal band are longer and narrower than those of the upper surface to the right of *l*. *s*, part of the adjacent lower stomatal band; *us*, one upper stomatal band; *m*, median epidermal cell band of upper surface over midrib. Both figures show characteristic auxiliary stomatal cells especially in the lower cuticle. These and the ordinary epidermal cells should be compared with better focussed cuticle from Bournemouth (CHANDLER 1963: pl. 1, fig. 6).
- Fig. 3. More proximal fragment of ventral cuticle from same leaf. *mv*, ordinary epidermal cell band overlying midrib (Compare CHANDLER 1963, pl. 2, figs. 7, 10, from Boscombe, Bournemouth).
- Fig. 4. Another fragment of upper cuticle over midrib from same twig. Edge of stomatal band at *s*. Lower end of fragment at top of figure.

N.B. In all cuticle photographs the impact of light appears to have been slightly oblique, causing reflection from cell walls with resulting apparent discontinuity of some cell outlines and emphasizing pits in walls and impurities in cells.





## PLATE 15

### *Pinus fordi* n.sp.

- Fig. 1. Cone, tip imperfect; deciduous scales have fallen at base exposing the bare axis. Low convex apices of scales are shown and their rough irregular surfaces. x 1.5. (V.51692)
- Fig. 2. Same, opposite, side, more abraded so that longitudinal parallel nerves beneath surface of scales are exposed where pyrites encrustation does not conceal them. Deep hollows for the accommodation of seeds on scales below are seen beneath lowest scales preserved. x 1.4. Hamstead Beds, Newtown.

### Palmae. Genus ?

- Fig. 3. Internal cast of fruit which has become detached from remains of fruit wall. Cast shows impression of broad longitudinal fibres of exocarp. x 6.5. (V.51689)
- Fig. 4. Opposite side of same cast. The dark object at v is a seed of *Rhamnospermum* closely adherent to cast. x 6.5.
- Fig. 5. Stalked base of exocarp of same detached from cast. Mineralized fibres of the coat are seen in section on the edge nearest to the camera. x 6.5.
- Fig. 6. Same, opposite side, tilted to show part of inner surface with fibres (slightly out of focus). x 6.5. Hamstead Beds, Bouldnor.

### *Sabal major* (Unger) Heer

- Fig. 7. Ironstone cast of the central part of a typical leaf, upper surface showing rachis, r. The ligule is torn away at l, proximal margin of leaf centre. All pinnae very incomplete distally. x 0.9. (V.51693).
- Fig. 8. Same, lower surface with broad tapering rachis. Reflexed lower pinnae seen on right. All pinnae and tip of rachis, r, broken distally. x 0.9. Base of Hamstead Beds, on shore below Bouldnor Cliff, Yarmouth, Isle of Wight. V.51689. *In situ*.

N.B. All cones from Bouldnor shore were photographed and described before treatment in the laboratory in an attempt to preserve them permanently, since when, much of the detail is less clearly seen.



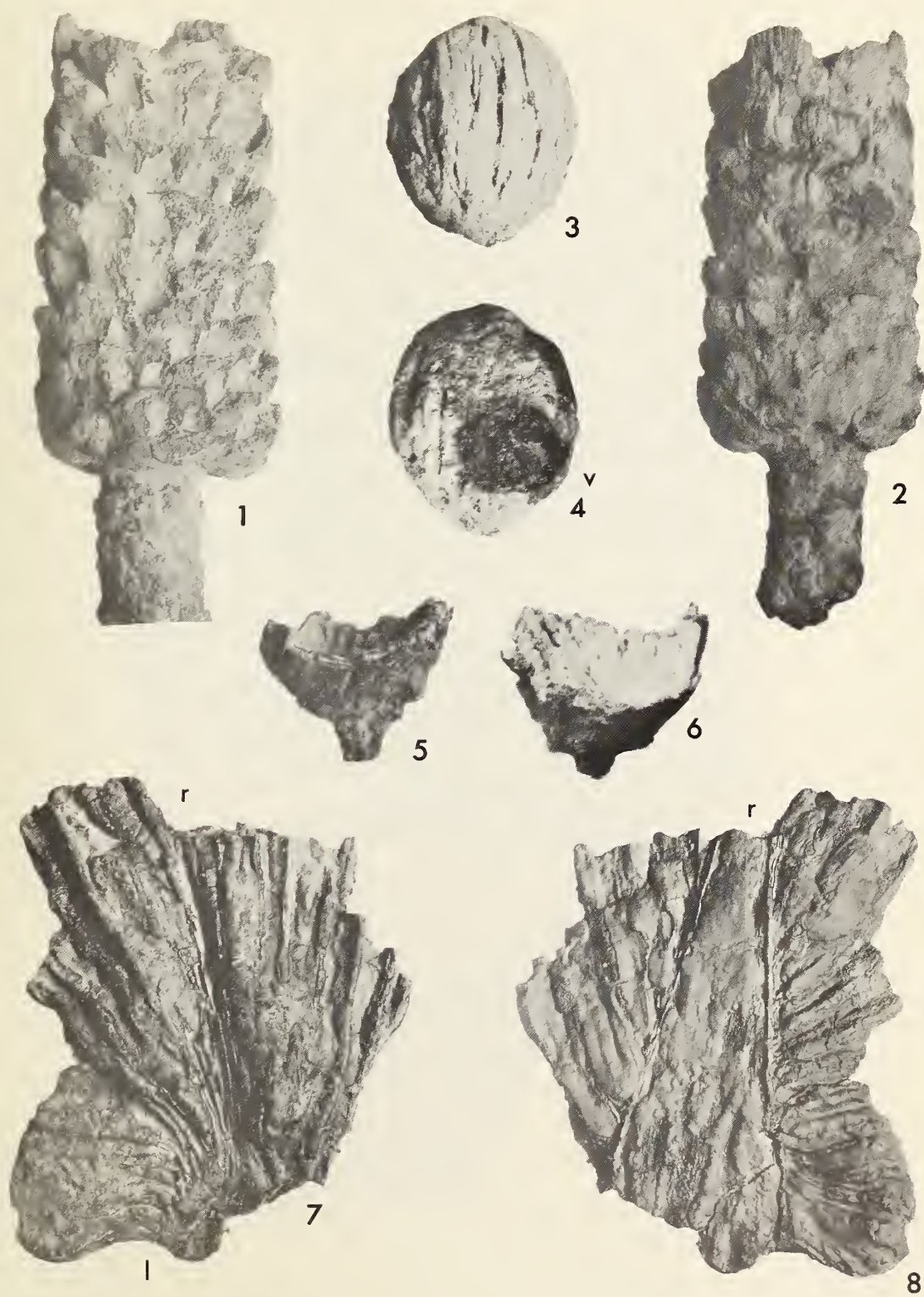


PLATE 15

## PLATE 16

### Pinnate Palm. Genus?

- Fig. 1. Fragmentary impression of upper surface of leaf. Rachis represented, on left, by its margin only. It bears twelve pinnae incomplete at their distal ends. x 0.5 approx. (V.45000). Split ironstone slab on shore east of Yarmouth, Isle of Wight, probably from Hamstead Beds (see p. 43).

### *Aldrovanda intermedia* Reid & Chandler

- Fig. 2. Seed, side showing hilar aperture, *h*, at end of neck and mucro over chalaza at opposite end of seed. x 16. (V.51818).
- Fig. 3. Another, showing median longitudinal ridge due to raphe. x 16. (V.51819).

From pocket 100 yards east of cone bed below high water mark, Hamstead Beds, Bouldnor Cliff, Yarmouth, Isle of Wight.





PLATE 16

PLATE 17

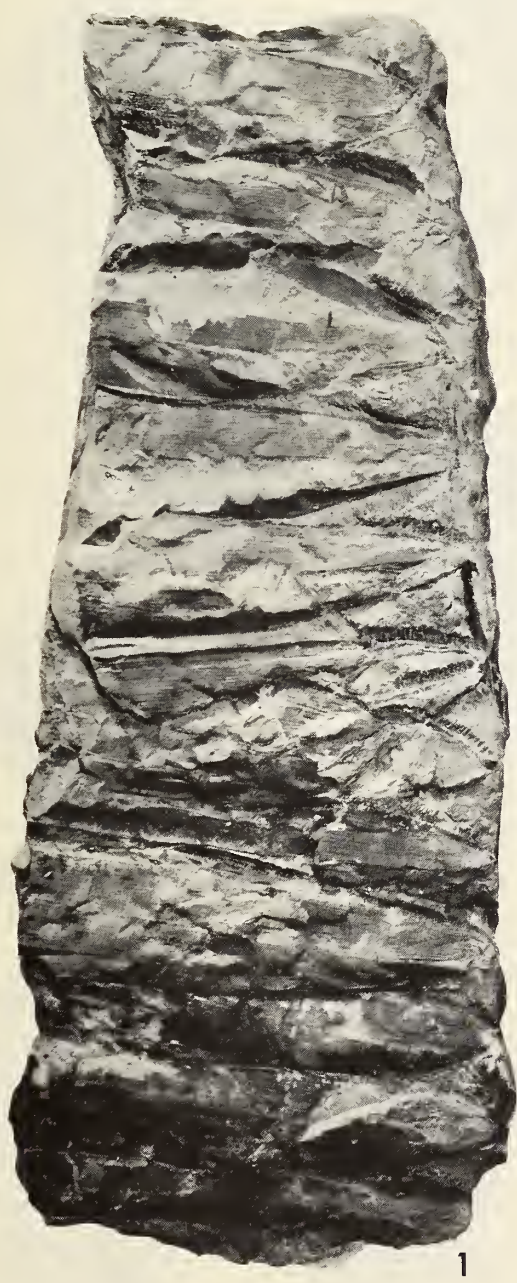
Pinnate Palm. Genus ?

- Fig. 1. Impression of lower surface of leaf fragment. Counterpart of that in Pl. 16, fig. 1. Margin of rachis on right. x 0.5 approx. Magnification in CHANDLER 1964, pl. 4, fig. 31 should have been x 0.25. V.45000). On shore east of Yarmouth, Isle of Wight. Probably from Hamstead Beds.

*Sequoiadendron fordii* n.sp.

- Fig. 2. Carbonaceous cone still attached to twig, t. Scales partly obscured by film of pyrites at distal end (above). An equal-sided quadrangular scale escutcheon is at s and narrow transversely elongate escutcheons (cracked transversely) are visible below. x 3. (V.51682). *In situ*.
- Fig. 3. A cone sufficiently immature for some of the escutcheons to retain an almost unshrunk central mucro, m. x 2.5. (V.53545). Base of Hamstead Beds, shore below Bouldnor Cliff, Yarmouth, Isle of Wight.





1



s

2

t



m

3

## PLATE 18

After the manuscript had been handed in for publication, some important additions to the relevant material were received at the British Museum (Natural History) in 1967. Descriptions were introduced into the Text and additional plates 18 and 19 were prepared to illustrate it.

### *? Sequoia couttsiae* Heer

- Fig. 1. A much abraded cone with pyrites accretions at the top. x 2 approx. Schleswig-Holstein Geological Survey Collection. Lower London Clay, on shore mixed with glacial gravels, Katharinenhof, Fehmarn Island, Schleswig-Holstein.

### *Sequoia couttsiae* Heer

- Fig. 2 A beautifully preserved cone with stalk, scales covered by pyrites film, for comparison. x 2. (V.53031) Hamstead Beds, shore below Bouldnor Cliff, Yarmouth, Isle of Wight.

### *Nipa burtini* (Brongniart) Ettingshausen

- Figs. 3-5 Three fruits, figs. 3, 4 incomplete at base. Fig. 5 much pyrites encrusted, especially at apex. x 1. (V.52789). London Clay, Burnham-on-Crouch, Essex, new locality.

### *Wetherellia variabilis* Bowerbank

- Fig. 6. Coccus, ventral face, showing median plane of splitting and hollow from which seed has fallen. x 2.  
Figs. 7, 8 Another larger coccus which has split in plane of locule showing pendulous seed, s, suspended by long arched funicle at f. x 2.5.

### *Lobaticarpum variabile* Reid & Chandler

- Fig. 9. Four-loculed fruit, apex, with one of the floats largely destroyed by abrasion. Floats above and below show apertures from which fibres? originally protruded. x 2.

### *Leucopogon quadrilocularis* Reid & Chandler

- Fig. 10 Four-carpelled fruit, apex, abraded so that the four locule casts are exposed. x 2.7.

Figs. 6-10 Schleswig-Holstein Geological Survey Collection.  
From Katharinenhof, Fehmarn Island. See above.





PLATE 18

PLATE 19

*Anonaspermum* sp.

- Figs. 1, 2. Seed. Fig. 1 margin with raphe. Fig. 2 broad surface at 90° to Fig. 1. Albumen exposed at a, where testa has flaked away. x 3 approx. Decayed. Barton Beds, Barton Cliff, Hampshire. (V.29217)

*Pinus fordi* n.sp.

- Fig. 3. Cone in Pl. 15, figs. 1, 2 completed by the recent discovery *in situ* of the distal half. j, junction of two portions. The bare axis is seen at base. x 1. (V.51692)
- Fig. 4. Distal end to show thick well-defined but worn escutcheons of scales best seen at e. x 2.

*Pinus* sp.

- Fig. 5. A shorter stouter cone showing escutcheons. A few scales at the base are now missing. x 1.25. (V.53033)
- Fig. 6. Same at 90° to fig. 5 showing compression of specimen and tapering to missing base. x 1.25.

? Unidentified flower

- Fig. 7. Much pyrites-encrusted specimen crushed obliquely with long stalk. Conical ovary, o, longitudinally ridged owing to shrinking, whorl of subcircular stamens, s. The projection at p is an adherent fragment not part of the specimen. x 1.25. (V.53032).
- Fig. 8. Same, opposite side, showing stalk broadening upwards, stamens at s; tip of ovary, o, projecting beyond stamens. x 1.3 approx.

Figs. 5-8 Hamstead Beds, on shore below Bouldnor Cliff, Yarmouth, Isle of Wight.



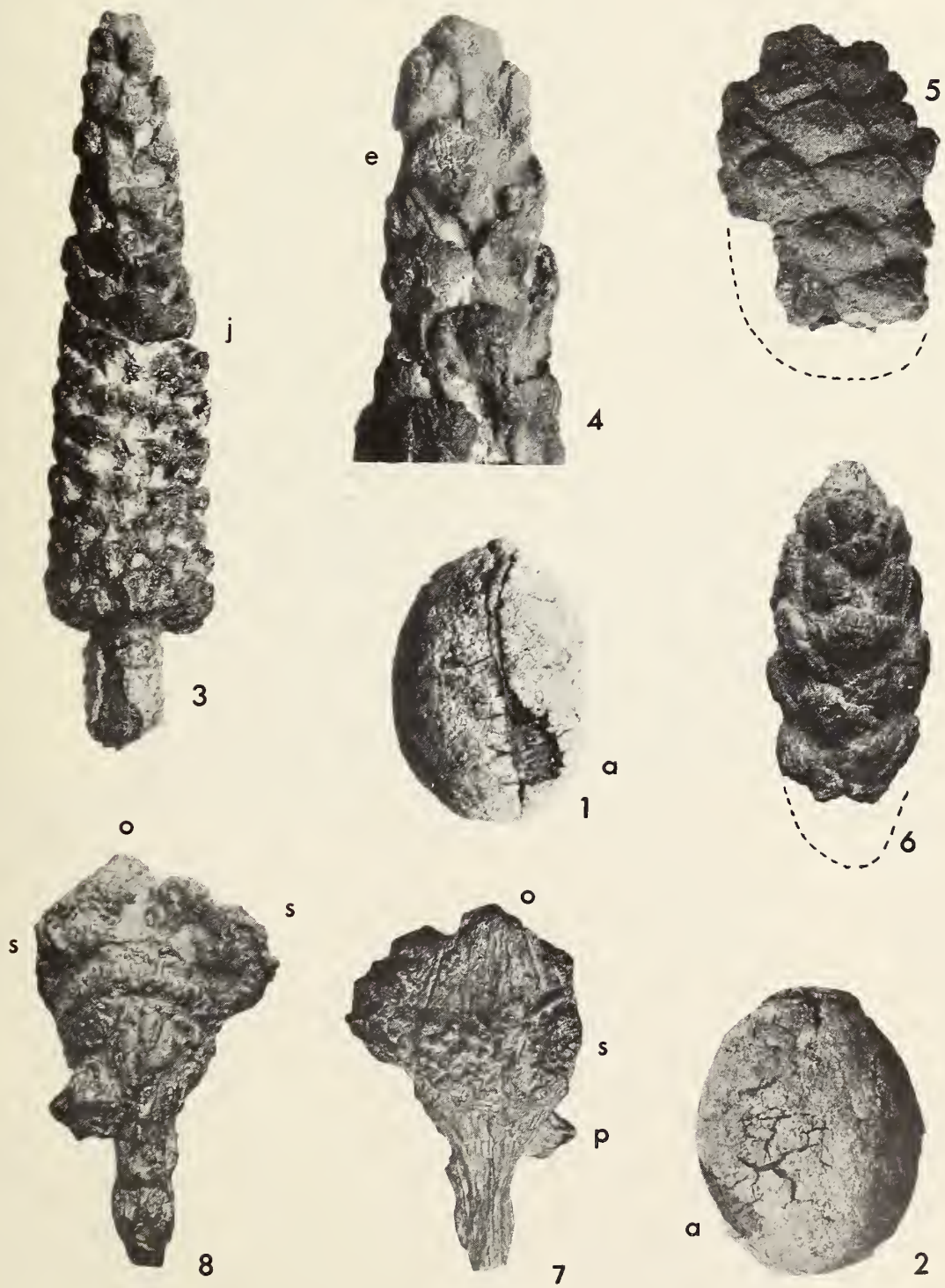


PLATE 19

PLATE 20

*Sequoia couttsiae* Heer

The undersides of two ironstone slabs showing *Sequoia couttsiae*. From the base of the Hamstead Beds, Bouldnor, Isle of Wight.

Photo: Robin FLETCHER. Specimens in R.L.E. FORD Collection.



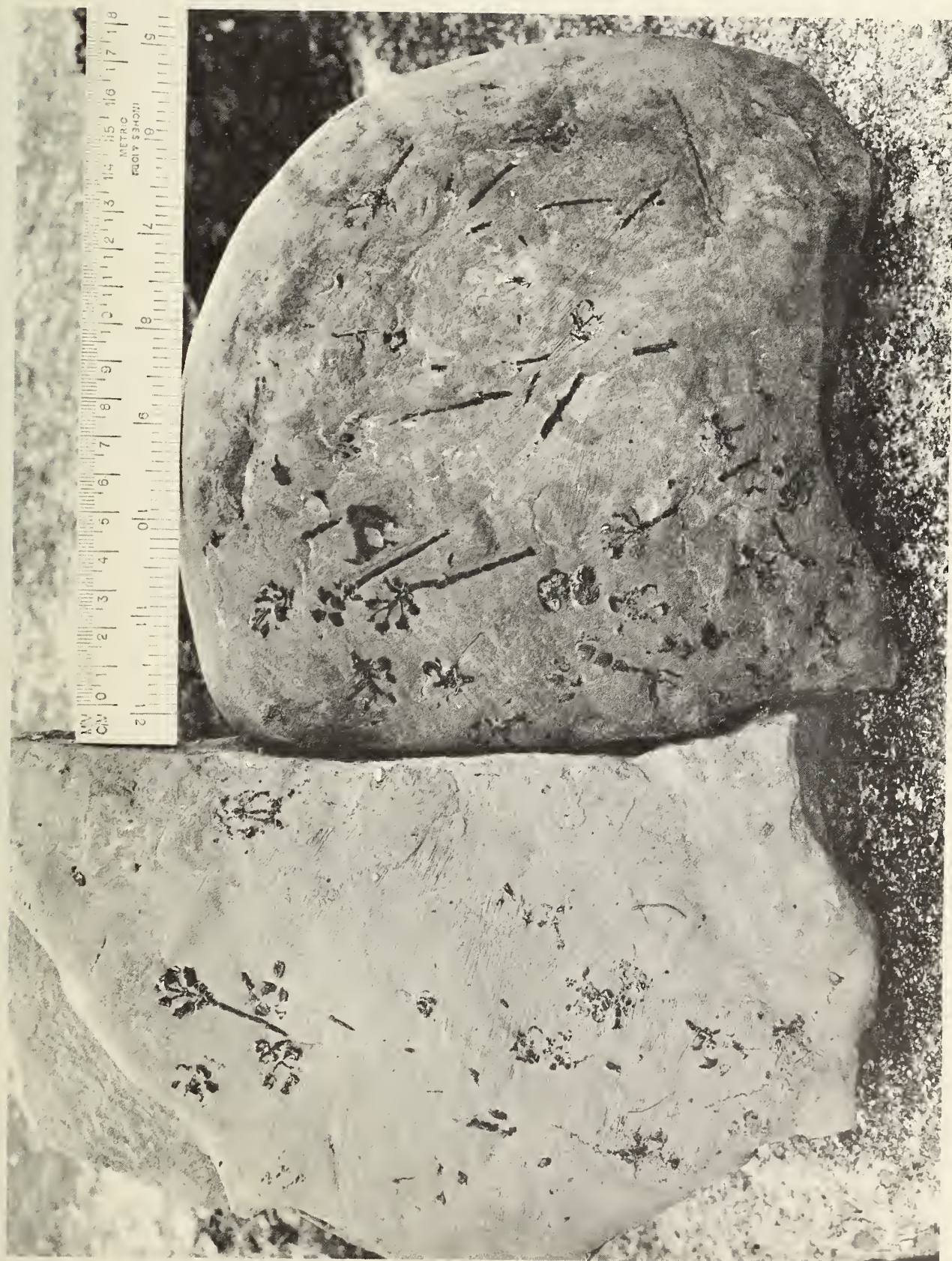
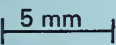


PLATE 20

BRITISH MUSEUM  
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## INSTRUCTIONS TO CONTRIBUTORS

Two copies of the typescript, in English only, and two copies of the figures and/or plates, either reduced to their intended publication size or x 2 should be submitted to the Editor. The author should retain a complete copy of his paper. The article should be typed on A4 paper, double spaced, on one side only with adequate margins. Each article should be preceded by an abstract and should conform to the layout and conventions of *Tertiary Research*. The maximum area for figures or plates is 160 mm x 240 mm. Figures should be in Indian ink on good white board. Letraset or stencil lettering should be used. Scales should be indicated by a bar with an accompanying measurement, thus: . Measurements should be given in metric units only. When comparing metric with Imperial units in older literature, Imperial equivalents should be quoted in addition (due to differences in "rounding off" between the two systems). Standard stratigraphical and palaeontological conventions should be followed throughout, or the source is to be quoted.

References to other publications should be represented in the text by the author(s)' name(s) in CAPITALS followed by the year of publication and page numbers where appropriate, e.g. **SMITH 1976: 24-32**. More than two authors should be quoted in the text as **SMITH, BROWN *et al.* 1976**. All references included in the text should be listed alphabetically by authors at the end of the paper. More than five authors of a paper should be quoted as: **SMITH, A.B. and sixteen others 1976**. Original capitalisation of titles of papers or books should be followed and abbreviations of journals must conform to the *World List of Scientific Periodicals*. Volume, part and page numbers should appear thus:

**EDWARDS, R.A. 1976. Tertiary sediments and structure of the Bovey Basin, south Devon.**  
*Proc. Geol. Ass.* **87 (1): 1-26.**

Books or separate works should be cited in the following manner:

**ARKELL, W.J. & TOMKIEFF, S.I. 1953. English Rock Terms. Chiefly as used by Miners and Quarrymen.**  
**London: Oxford University Press. 139 pp.**

Personal names in the text should also be in capitals, e.g. **WHITAKER**.

Localities referred to in the text should conform to the best-known name for the locality; local alternatives should also be given. All should be accompanied by precise grid references. Sites outside the United Kingdom should be localised by their latitude and longitude, or by reference to a particular map, chart or local arrangement.

Wherever possible, dates of publication of taxa should follow the author's name, e.g. *Xenophora extensa* (J. Sowerby 1821). Significant taxonomic changes should be indicated by the addition of the revising author and date, e.g. *Trochotugurium extensum* (J. Sowerby 1821) Cossmann 1915.

The location of material (particularly type material) listed or referred to must be stated.

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